

# GMS apps on Low RAM - leadership update

Teddy Wonderwosen, Madan Ankapura @ | 25, May 2016 | Google Confidential

[go/gmslite-ilio-leader](https://go/gmslite-ilio-leader)  
[go/gmslite-ilio](https://go/gmslite-ilio)

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- Hi -

**EXHIBIT 5963.R**

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GOOG-PLAY-003687133.R

**EXHIBIT 5963.R-001**

# Agenda

**A. Background**

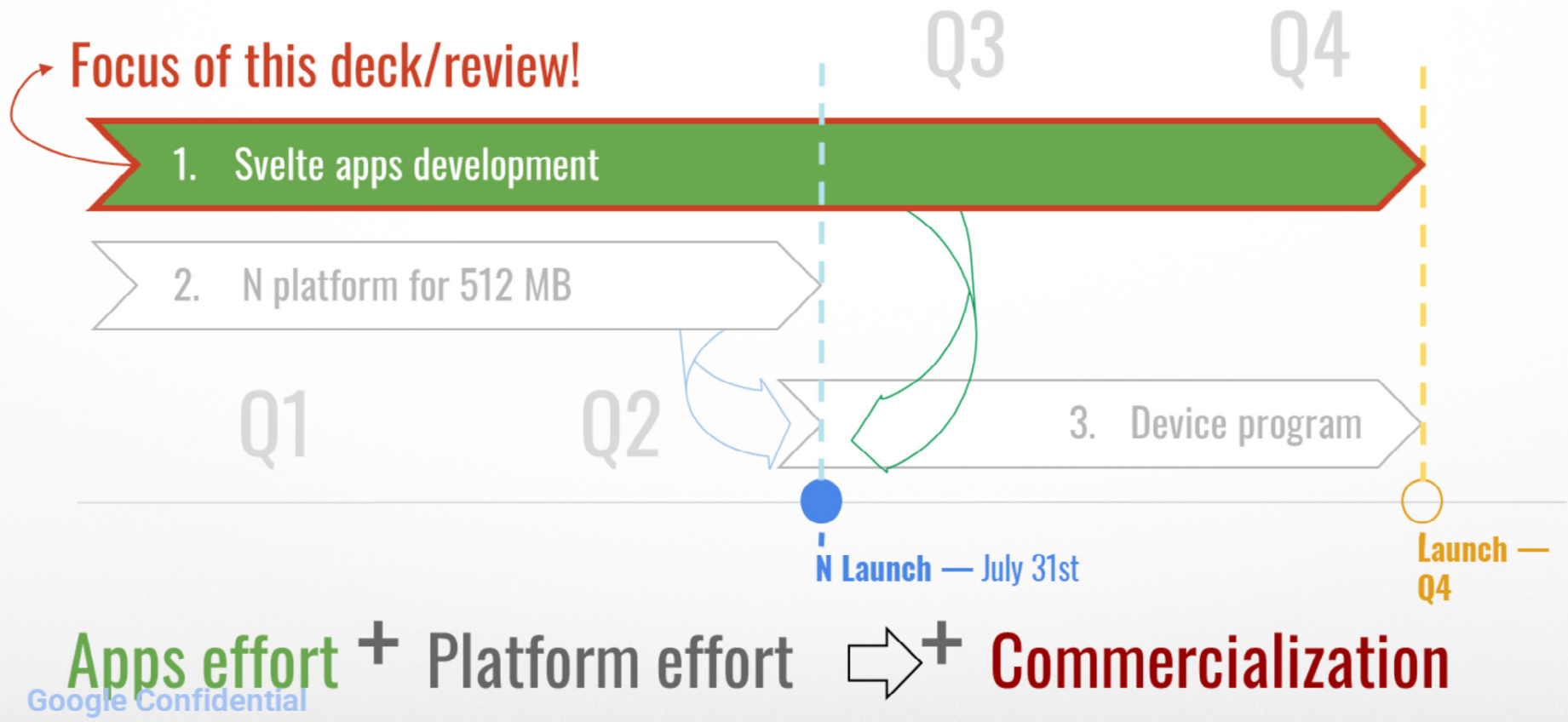
**B. Core GMS app status for Svelte Devices**

**C. Introducing the Budget**

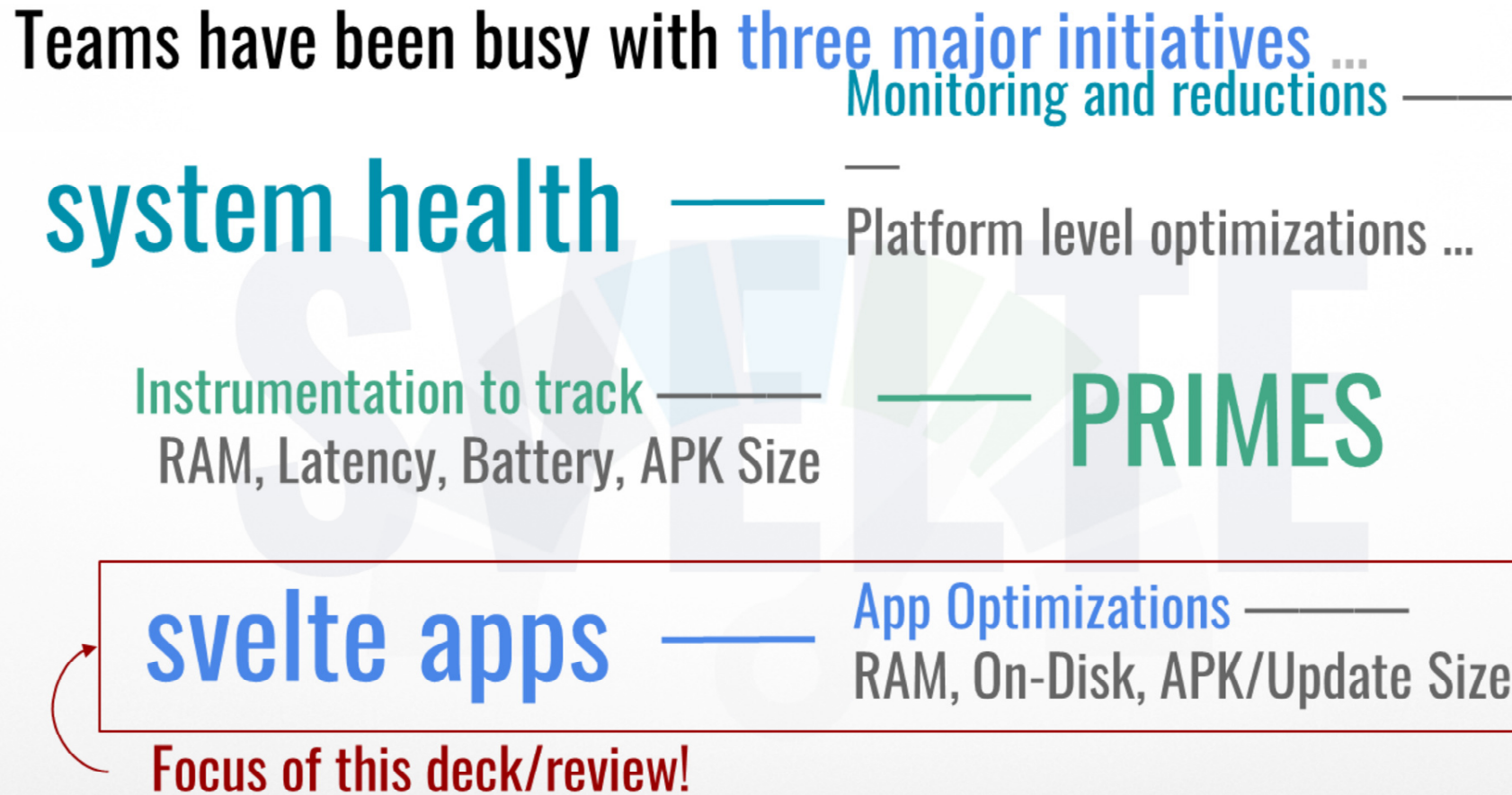
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# We'd like to bring 3 distinct and critical pillars of the Svelte platform/apps strategy together in 2016 ...



- There are 3 distinct pillars for Android to be still relevant in the entry level.
- Today we will focus on the overview/status of the app teams outside of Android PA. This effort coupled with the performance standup that Dave Burke's team is running will help bring to market a svelte device with GMS. The details of the device itself are not finalized but we do have few ideas that we can touch later, or come back with a more concrete plan.



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- Team has been busy with 2 initiatives driven by outside of the app teams - SYSTEM HEALTH which is tied to launchcal bit & PRIMES which is to track instrumentation

# Today, OEM's options for shipping GMS on 512 MB devices are not ideal ...



All 8 Apps are part of an "all apps, or nothing" pre-install bundle ...

... so, OEMs' choice becomes:

- a) 1 GB *with* GMS *OR*
- b) 512 MB *without* GMS

Performance/usage on Svelte is *not acceptable*

... So, Today BDs / TAMs recommend **NOT** shipping GMS w/ 512 MB ...

... but we want to be able to recommend and support 512 MB with GMS!

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- CDD allows 512MB with GMS (Svelte) but performance on Svelte is not acceptable - so, BDs / TAMs recommend NOT shipping GMS with 512 MB of RAM ..
- For example, the Pamoja (Africa) device was originally intended to launch with 512 MB, but ultimately launched with 1GB via a \$2 subsidy to the OEM for the additional RAM ..
- Basically then, OEMs' choice becomes: a) ship 1GB with GMS OR b) ship 512 MB without GMS .. both of these options are commercially viable to OEMs, so it's us who needs to ensure that they are incentivized and officially encouraged to ship 512 MB devices with GMS (Svelte).

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We have been talking to **ALL Core GMS Apps teams** ...

- A. 1:1s w/ Apps Eng/TLs** : fact finding
- B. Roadshow #1** : w/ Apps TLs (w/ PRIMES)
- C. App TL Summit** : Svelte/GMS Lite apps update
- D. Roadshow #2** : w/ Apps TLs/Leadership [ongoing]
- E. Android Leadership PR** : Svelte/GMS Lite [today]

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# State of GMS Apps progress ...

Blue = Using Lite App #s, assuming pre-install for Svelte  
Purple = Missing in PRIMES - Procstats #s used

Source & Scoring/Weighting:  
[APE/PRIMES/B4B GMS Lite Apps Tracker](#)

Weights	170.00		2.5	35		10	10	10	10	10	10	10	5	5	5	5	5	5	5	5	5	5	5	5	5
App	APE w/ B4B (max = 135)	APE w/ B4B Score %	Target Date	Use is LowRAMDevice()	isLowRAMDevice() Multiplier	PRIMES Play D/L Patch Size Monthly*	LDPI Disk Size	PRIMES Median APK on Low RAM	PRIMES Low RAM FOREGROUND RAM*	PRIMES Low RAM BACKGROUND RAM*	PRIMES Low RAM BG-FG Ratio	Active Global User Penetration on Low RAM	PRIMES RAM and APK?	TikTok / Stitch?	Top EM App	Uninstall Rate	Telephony Manager	GCM	Memory Class	Intent Device Low Storage	Intent Network Usage	Job Scheduler	App Compat Support Library	Material Design Score	
Ideal			Q3'16	Yes	1	5.00	24.00	15.00	31.00	19.00	0.61	100%	Production	Yes											
AGSA	128.62	75.66%	Q2'17	Yes	1	18.95	56.37	47.20	45.85	42.89	0.94	-56%	Production	No	TRUE	11%	1	1	1	0	0	1	1	0.9	
Calendar	97.26	57.21%	—	Yes	0.33	10.01	30.00	22.48	22.49	19.74	0.88	-93%	Production	No	FALSE	9%	0	1	0	0	1	0	1	0.8	
Chrome	116.48	68.52%	Q4'16	Yes	1	15.97	83.59	42.04	58.72	37.37	0.64	-60%	Not Planned	No	TRUE	14%	0	1	1	0	0	1	1	0.5	
Drive	134.16	78.92%	Q2'17	Yes	1	7.78	32.60	19.83	28.99	26.14	0.90	-79%	Production	No	FALSE	14%	1	1	1	0	0	1	1	0.5	
Gmail	127.52	75.01%	—	Yes	1	10.04	19.88	17.32	32.29	31.33	0.97	-73%	Production	No	FALSE	14%	0	0	1	1	1	1	0	0.6	
Google +	129.95	76.44%	—	Yes	0.33	12.95	36.89	23.22	23.55	20.53	0.87	-1%	Production	Yes	FALSE	20%	1	1	1	1	1	1	1	0.8	
Hangouts	115.67	68.04%	Q2'16	Yes	0.33	13.42	45.46	28.23	35.45	31.38	0.89	-40%	Production	No	FALSE	22%	1	1	1	1	0	1	1	0.5	
Maps	89.32	52.54%	—	No	0	19.32	46.90	33.10	51.87	49.27	0.95	-78%	Production	No	TRUE	12%	1	1	1	0	1	1	0	0.8	
Photos	134.42	79.07%	—	Yes	1	14.60	41.62	24.18	35.61	33.65	0.94	-85%	Production	Yes	FALSE	23%	0	1	1	1	0	1	1	1	
Play Movies	126.37	74.34%	—	Yes	0.33	7.34	17.73	10.60	37.67	19.02	0.00	-44%	Pending	Yes	FALSE	19%	1	1	1	0	1	1	1	0.7	
Play Music	127.54	75.02%	—	Yes	0.33	16.01	28.84	13.78	20.43	16.52	0.00	-35%	Pending	No	TRUE	16%	1	1	1	1	1	1	1	0.8	
Play Store	113.11	66.54%	Q3'16	Yes	0.33	6.29	25.55	12.58	45.07	44.48	0.99	-57%	Production	No	TRUE	0%	0	1	1	0	1	1	1	1	
YouTube	102.26	60.15%	Q1'17	No	0	11.74	32.68	22.00	47.27	46.62	0.99	-59%	Production	No	TRUE	16%	1	1	1	0	1	1	1	0.8	
Webview*	40.16	50.19%	—	Yes	0.33	18.13	54.72	34.20	—	—	—	—	Not Planned	No	—	3%	—	—	—	—	—	—	—	—	
Average		70%			Averages	12.65	38.32	24.35	37.33	32.23	0.77	-58%													
					Medians	12.95	32.68	22.48	35.61	31.38	0.90	-59%													

Goal = 85+ for each app and 85+ average for all apps

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- APK and Size on Disk is measured on-device on an mdpi (typical Svelte type device) device..
- For teams with a Lite version of their app, the Lite app's #s are used in lieu of the Main app's #s..
- RAM is measured via PRIMES instrumentation - for those teams who've implemented in either the Production or Alpha/Dogfood Play channels .. It is the median determined from the app usage of opt-in users ..
- For teams with a Lite version of their app, RAM #s are used in lieu of the Main app's #s..
- Server/Client optimizations - Server Side example: rendering browser content on the server and serving the content as a compressed image to the user;
- Client Side example: allowing photos to be taken without the need to upload the photo or any related data to the cloud, and allowing features on the client-side like auto-awesome instead of requiring the image be sent back to our servers to enhance then sent back ..
- isLowRAMDevice() - Usage of the isLowRAMDevice() flag to hide / degrade 1 or more features / capabilities in the app — as for specifics, we're currently beginning to track how each of the apps teams are utilizing this flag and plan to share them broadly to encourage more usage where applicable ..

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# Evaluating Apps on Svelte - what metrics did we use?

Lite Initiative Exists?

Lite Target by Q4?

Efficient / Separate APK  
Reductions

In-App Data Usage

Using is Low RAM Device()

Recent APK Patch Size

BRIIM Usage Ratio (Min/User)

**PRIMES** Median / Lite BG

RAM Uninstall Rate

**PRIMES** Instrumented?

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- Why did we choose these metrics?
- Lite Initiative: Having a Lite Initiative is a key driver for significantly reducing RAM, Update Size, On-Disk Size, and other critical metrics
- Lite Target Date: Since we hope to initiate and launch a device program, as well as since we have SoCs / Partners looking for a GMS Lite bundle, a Target Date is key to having sufficient visibility to bring a device program and related outputs to bear by EOQ4'16;
- Efficient/Separate APK: Lite APK is <= 14MB and/or can run separate from its Main app counterpart — Lite apps that rely on Main apps don't address the Disk Size or APK Update size issue when considered on aggregate;
- In-App Data Usage: Reducing data/bandwidth use while in-app is a critical consideration for Svelte devices because these devices are of course in BRIIM/NBU regions where data availability is generally very limited and costs are high relative to per capita income;
- Using isLowRAMDevice(): Reducing RAM footprint on Svelte devices (all are low in RAM ~ 512 MB) by specifically turning features on/off is

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**EXHIBIT 5963.R-009**

- critical to improving performance and reducing jank;
- Recent APK Update Size: A core consideration for enabling updates on Svelte devices in BRIIM/NBU regions is size of the APK update. Additionally Play is rolling out BSDiff based updates which will help reduce update size;
- Latest MDPI/Lite Disk Size: Size of the app on disk is important considering most active Svelte/MDPI devices have just 4GB on-device storage - after system and GMS app files, its typical that there is < 2GB of space left for the user's apps/content;
- PRIMES Median/Lite App RAM: RAM is the cornerstone of performance on Svelte devices - instrumenting PRIMES and measuring RAM usage on Svelte devices is critical to meeting a  $\leq 40$ MB footprint;
- BRIIM Usage Ratio: Based on minutes of use per user, this is the ratio of Usage in Non-BRIIM/NBU countries to usage in BRIIM/NBU countries - ideally, the number should be 1 - a smaller ratio indicates lower usage in regions where Svelte devices are highly prevalent;
- Uninstall Rate: Uninstall rate north of a couple percent may indicate low usage - rates will be even higher in BRIIM/NBU countries, signifying low use/usefulness in those regions for the app, though it still sits pre-loaded taking up disk space in both the system and user partition (2x the actual size);
- PRIMES Instrumented: Instrumenting PRIMES is critical to facilitating a single platform and dashboard view for RAM, APK, Data, Battery, and Crash information across all 1P Apps, as well as very helpful to teams in their performance reduction efforts - especially for teams who don't have their own performance measurement instrumentation already;



## Support and advocacy Asks from Android Leadership ...

- + **GMSCore:** Support Audit of GMS Services and continue to optimize efforts to reduce RAM
  - + **Hangouts:** Support replacing Hangouts with Fireball(Allo) on Svelte devices only [**proposal in-flight**]
  - + **Maps:** Reduce APK on-device/update size;  
Move more features behind lowram flag;
  - + **YouTube:** Use isLowRAMDevice() in YouTube main app, to support existing svelte userbase;  
Allow Mango to replace YT Main app in svelte devices like Allo [**YT prefers not to cannibalize main app**]
  - + **Play:** Filtering support needed to target **Svelte devices** for GMS apps like YT [**prioritization needed**]
  - + **Chrome:** Allow monochrome to be preloaded only without webview on new devices [**per grace, confirmed**];  
Help reduce BG RAM usage to <=20MB & On-Disk size to <=25MB for svelte devices [**pre grace, not currently feasible**];
  - + **AGSA:** Move more features behind lowram flag like VoiceSearch & Now;  
Help reduce BG RAM usage to <=20MB and reduce APK Disk Size to <= 25MB;
  - + **Photos:** Reduce to/release reduced 14MB APK (potentially as Lite version); Reduce BG RAM use to <= 20MB;
  - + **Gmail:** Evaluate low app usage in svelte devices  
Reduce BG RAM usage to <=20MB;
- Support for **timeline convergence** from all Apps: **EQQ3'16** ...

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## We likely have the following options for apps on Svelte ...

Do Nothing

**Pros:** Less distraction for teams - continued focus on overall system health and premium

**Cons:** Competitor's lite apps continue to gain popularity and poach our future revenue/growth base

Introduce a Budget ...

**Pros:**

- Collective effort to meet RAM/ROM/Disk/Data budget;
- Quickest and most assured path

**Cons:**

- Collective responsibility may = lack of accountability,
- May need reducing GMS mandatory on Svelte from 8 -> ?

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## Budget Recommendation : RAM, Disk, Data Reductions ...

Average  
Background RAM

Today: **28 MB**

Proposed:  
**20 MB**

30% Reduction

MDPI Total  
Size on Disk

Today: **900 MB**

Proposed:  
**450MB**

50% Reduction

Total GMS Play  
Update Monthly

Today: **145 MB**

Proposed:  
**20MB**

85% Reduction

**RAM**

**DISK**

**DATA**

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# Appendix

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# svelte - why should we care?

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Why is the Svelte devices space a strategic advantage for  
Android .. and Google?

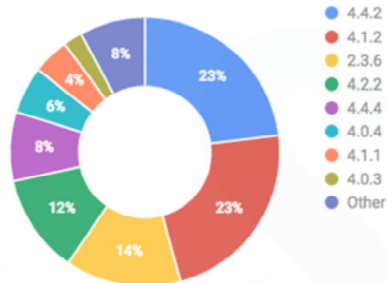
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- We can skip some of the these slides as needed but we wanted to recap why this is important for us

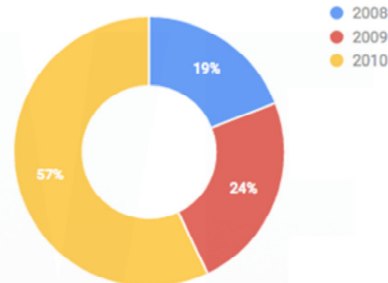


# Svelte: 512 MB devices running strictly KitKat or lower, 4GB ROM, and a 4" screen or smaller ...

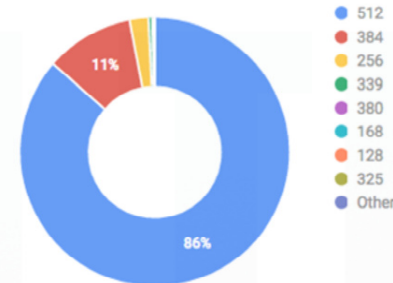
Android Release



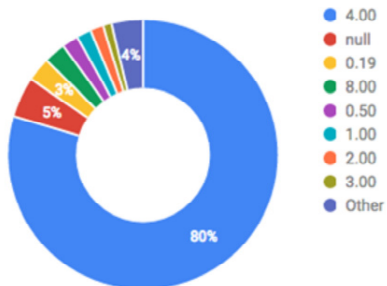
Year Class



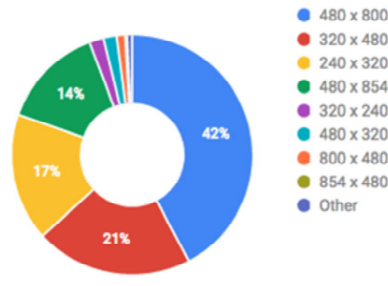
RAM



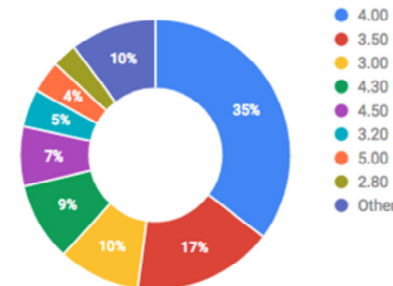
Flash Storage



Screen Resolution



Screen Inches



## SVELTE

Devices are slow ...  
Internal storage fills up fast ...

Hard to type, tap and see content ...

Battery dies faster -  
harder to use on the go ...

May not have latest  
version of apps ...

Sources: [Svelte Actives Slices ...](#)  
[Let There Be Lite ...](#)

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Half a billion Svelte devices active by EOY 2017 ...

~330M

# of Svelte devices currently active  
worldwide as of Q1'16 ...

+

~170M

# of Svelte devices estimated to be  
activated worldwide by EOY 2017 ...

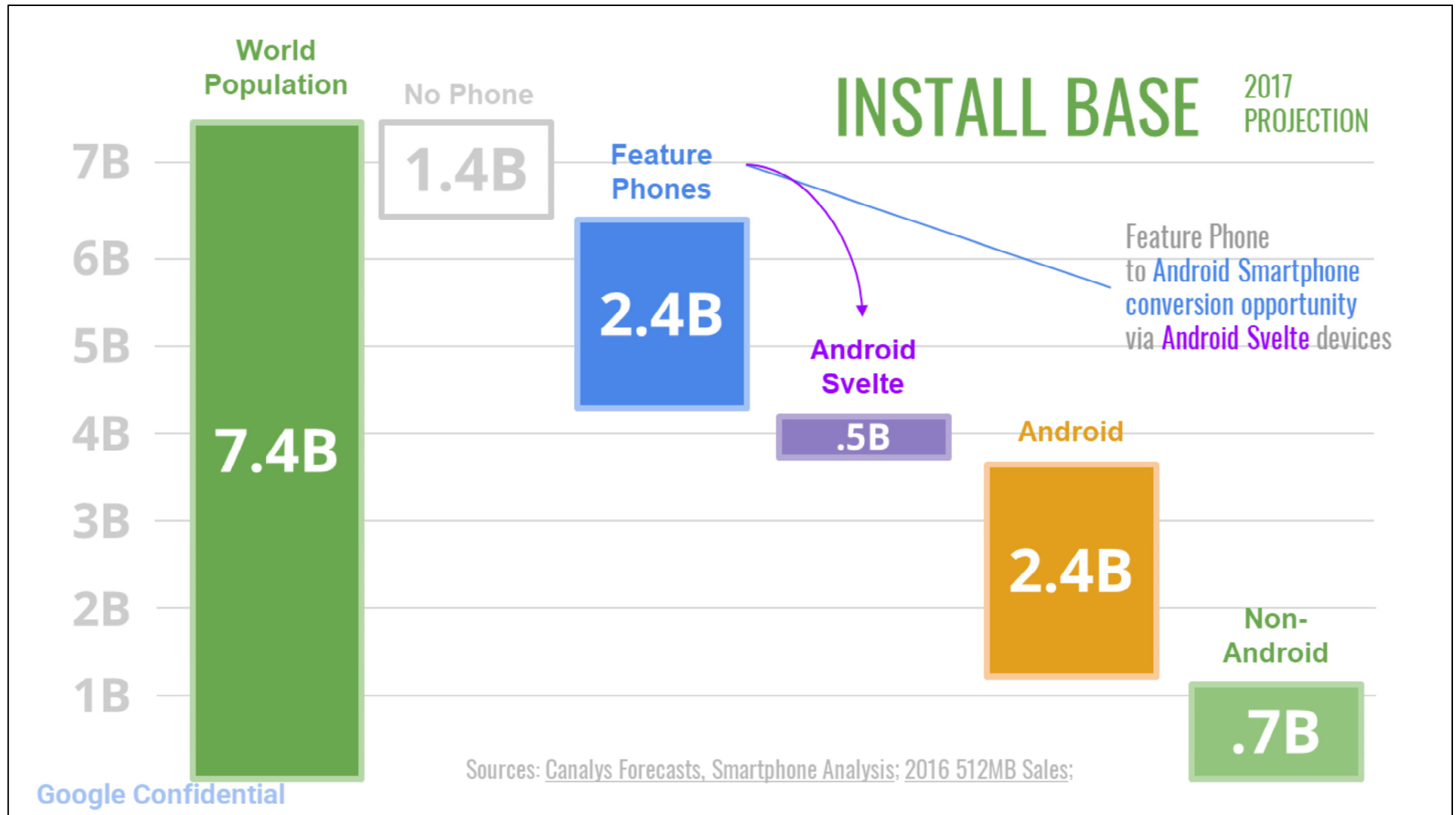
Low Cost  
Low RAM/ROM  
Lower Spec

~500M

Sources: YoY Low Ram Activations ..  
2016 512MB Sales ..

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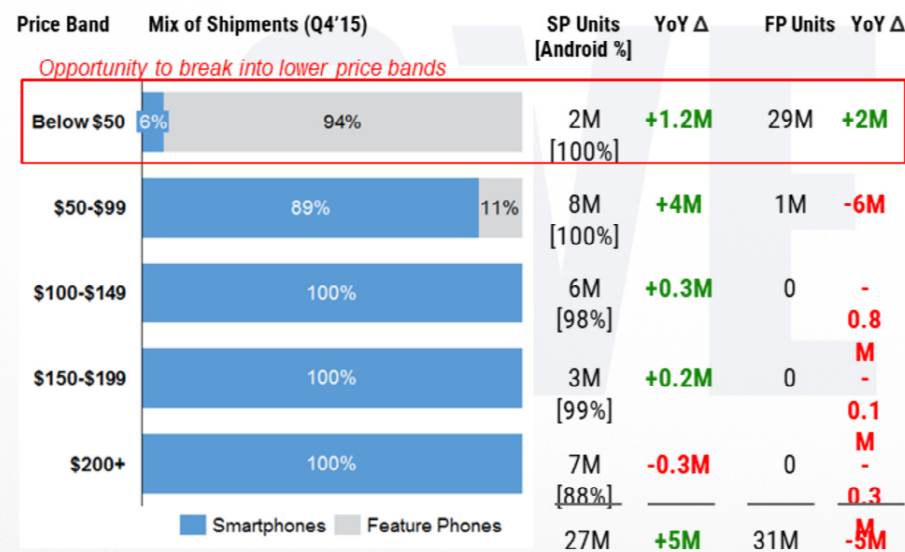
- The half a billion for Svelte devices is composed of the existing 330M active devices along with another 170M we expect to see added within the next year, bringing the total number of devices to 500M.



- We want Android device with GMS to be relevant in maximum possible market segments. There are more than 7+B ppl with 6+B phones WW. With just over 3.6+B smartphones, majority of the smartphones users in the future will be feature phone users upgrades to smartphones. That opportunity is HUGE and amounts to 2.4B TAM. Based on the forecasts, we expect the svelte class of devices with Android be at least half a billion.
- We have to note that this is the only class of devices that is growing YOY, we have a slide to show this later

# As presented to NBU x-PA Leads: opportunity to break into lower price bands where Feature phones dominate ...

## Smartphone vs Feature Phone Shipments (India, Q4'15)



→ India feature phone to smartphone opportunity ~30M units for Q4'15 ...

→ \$50 and below market ripe for disruption with Svelte smartphones ...

Sources: [Canalys](#), [Android Staples](#), [April NBU x-PA Leads Meeting \(incl. NBU Analytics\)](#) ...

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- We want Android device with GMS to be relevant in maximum possible market segments. There are more than 7+B ppl with 6+B phones WW. With just over 3.6+B smartphones, majority of the smartphones users in the future will be feature phone users upgrades to smartphones. That opportunity is HUGE and amounts to 2.4B TAM. Based on the forecasts, we expect the svelte class of devices with Android be at least half a billion.
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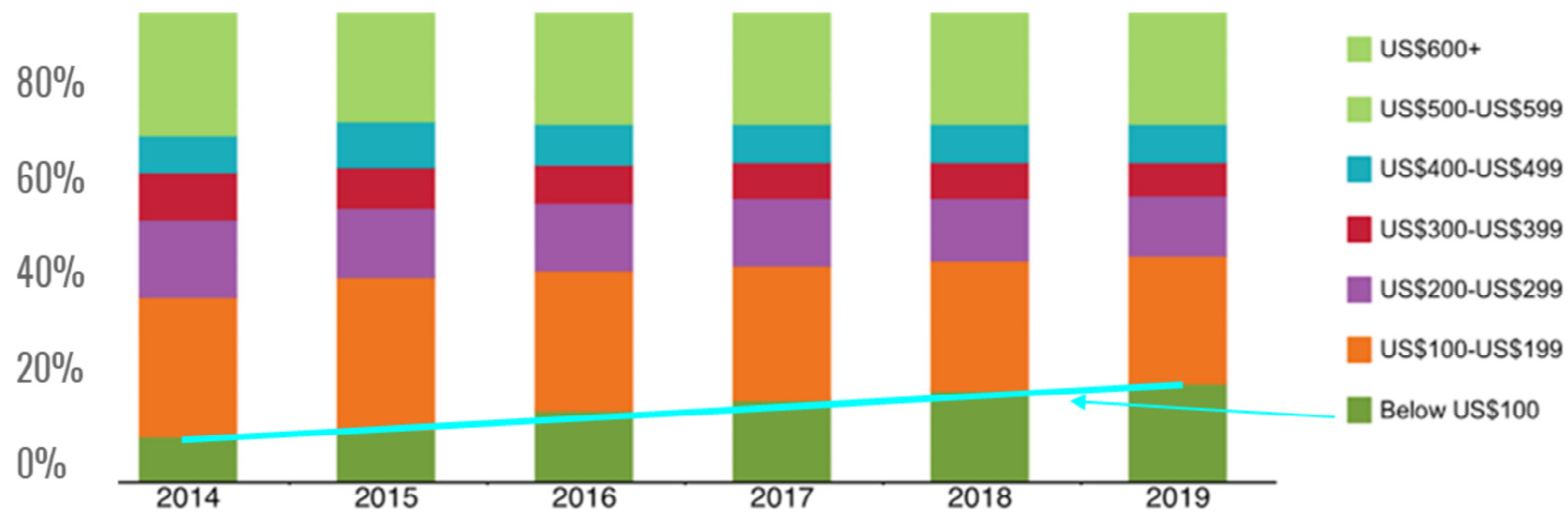
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# Relative growth *only* in Svelte range (< \$100), doubling by 2019 ... CAGR~9%

## Worldwide Smartphone Forecast by Price Band

% of Shipments



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Source: Canalys Forecasts, Smartphone Analysis, September 2015 ...

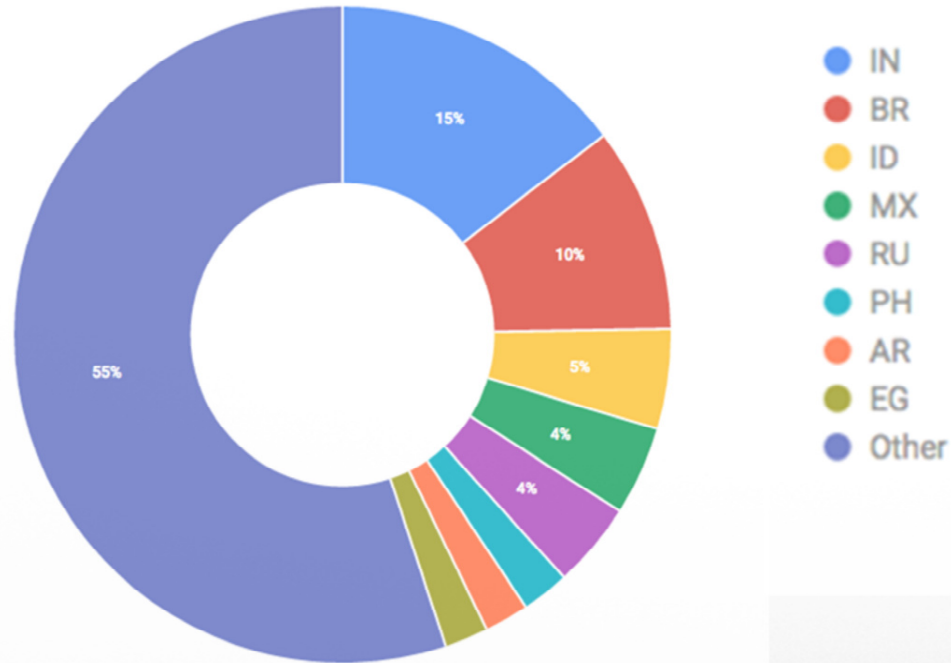
- The only growth area for smartphones is the below \$100 price range, which represents Svelte devices, doubling from 2015 to 2019..
- Other price-points are static or collectively shrinking as the below \$100 segment gains market share.

Why are Lite, Relevant apps running on Svelte devices a strategic imperative for Android .. and Google?

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- We can skip some of the these slides as needed but we wanted to recap why this is important for us

## Where are Svelte devices active? ... Mostly in BRIIM ...



**~40%** of Svelte devices are active in Brazil, Russia, India, Indonesia, and Mexico (BRIIM) ...

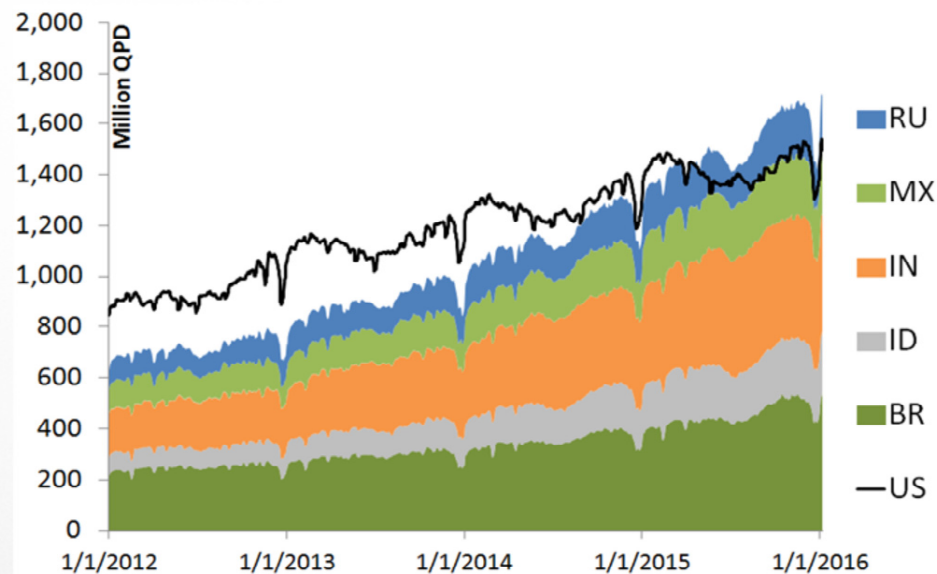
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Sources: Svelte Actives Slices ...

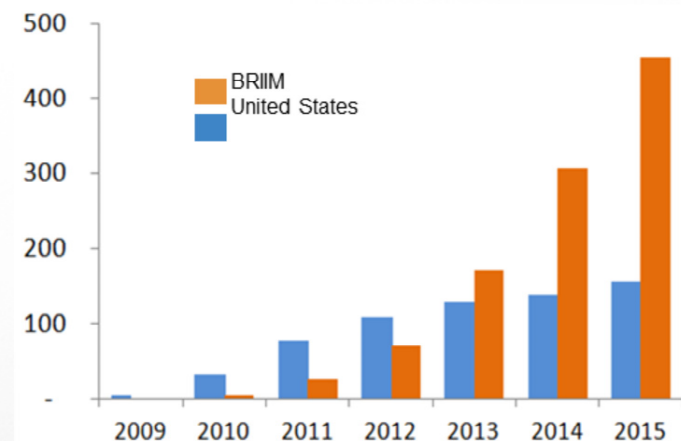


# 2015: BRIIM Search volume surpasses US ... *Future RPU!*

FUTURE RPUs **WILL COME FROM BRIIM** ...



ANDROID INSTALL BASE (M) ...



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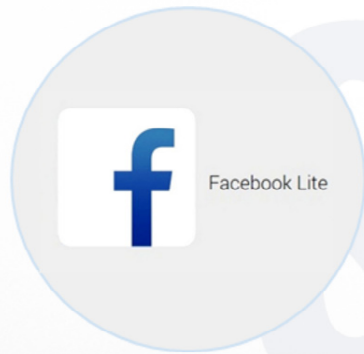
Sources: BRIIM AMSG Presentation ...

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# In these same BRIIM markets, competitors are launching Lite data / RAM / APK apps ...



**Facebook Lite**

**<1MB**

42x smaller than full app  
>100M d/l/s



**Opera Mini**

**1.2MB**

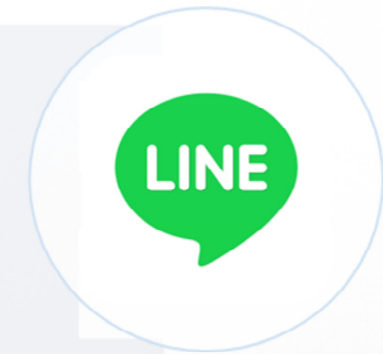
26x smaller than full app  
~100M d/l/s<sup>2</sup>



**UC Browser Mini**

**1.5MB**

10x smaller than full app  
~100M d/l/s<sup>1</sup>



**Line**

**<1MB**

34x smaller than full app  
~5M d/l/s

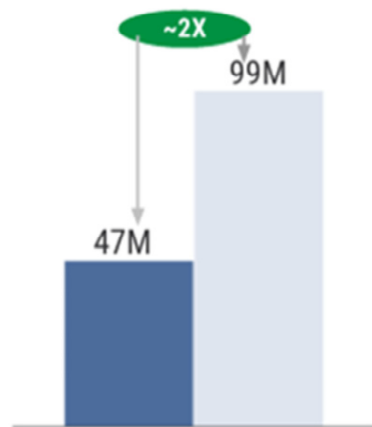
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# GMS engagement dropping YoY vs Android adoption ...

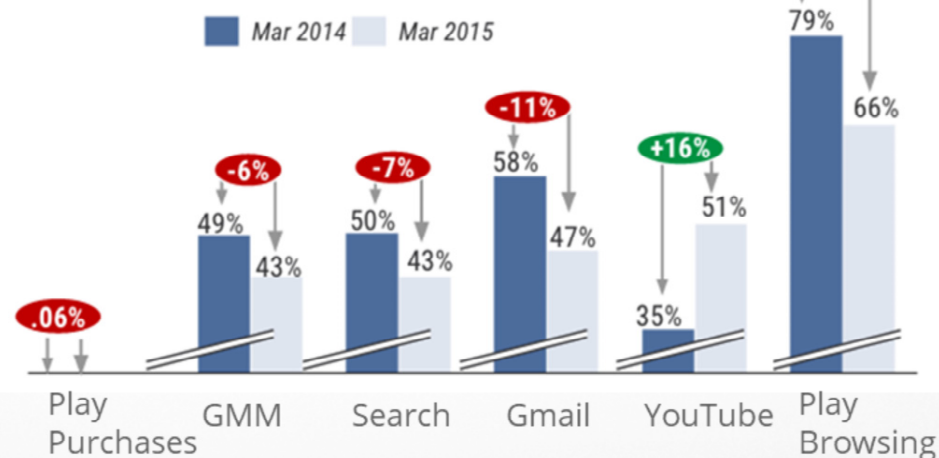
## ANDROID USER GROWTH

30DA Android users (+5M users/month)



## GMS ENGAGEMENT vs ANDROID USER GROWTH

30DA user for Google services as % of 30DA Android



Android adoption growing, but **GMS engagement dropping** ...

Our apps are **losing ground to competitors** on the platform **in the key growth markets** ...

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Sources: ULE Android for NBU ...

## FB, Carriers, OEMs working on custom ROMs ...

OEMs, Carriers  
working w/  
Custom ROM  
Houses on  
256 MB+ DEVICES  
running Android ...

**NON-COMPLIANT  
ANDROID  
FOR THE LOW END**

FB reaching out to  
ODMs and SoCs  
(MTK) to have FB  
Lite pre-installed ...

**FB LITE ON  
ANDROID FOR THE  
LOW END**

## THE RISK

Such implementations of Android targeting Feature Phone space pose a **greater threat to Google than simply capturing the low end** of the device market ...

Unlike GMS, FB, WhatsApp, other FB properties, and similar competitor offerings run excellently on low end devices, **gaining early user adoption on feature phones and maintaining this segment as they progress to smart phones ...**

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Sources: ULE Android for NBU ...

Slide 27

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1 [REDACTED] Google IT pretty interesting set of slides. Relevant to our interests  
Simon Tokumine, 11/26/2016

1 [REDACTED] Good to hear - you guys are definitely on it! :)  
[REDACTED] Madan Ankapura  
Teddy Wondwosen, 11/26/2016

# What does a **nightmare scenario** look like? ...



Current State

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## DISINTERMEDIATION OF GOOGLE ON ANDROID



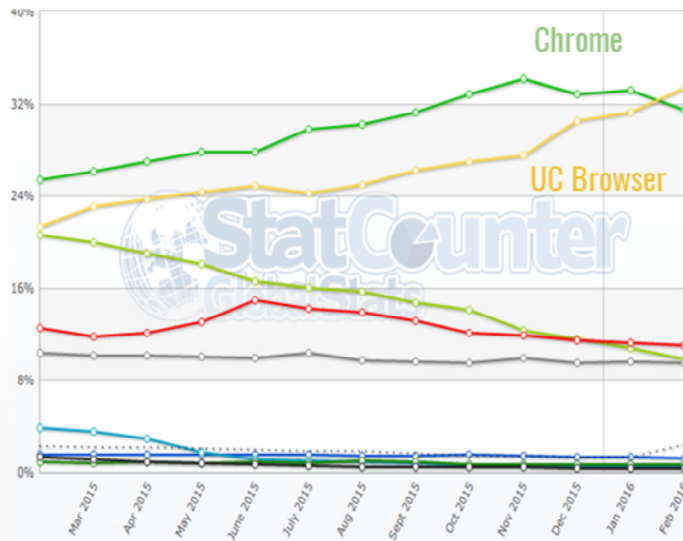
facebook middleware **platform**



>> Future State

Sources: ULE Android for NBU ...

We need to **experiment+launch+iterate** Lite apps **quickly** in key markets, **rather than hedge** with Main apps ...



- **Competitors aren't bundling** or building Lite into Main apps ...
- **Facebook Lite has 100M DAU** 8 months after launch ...

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ram, disk, data on svelte

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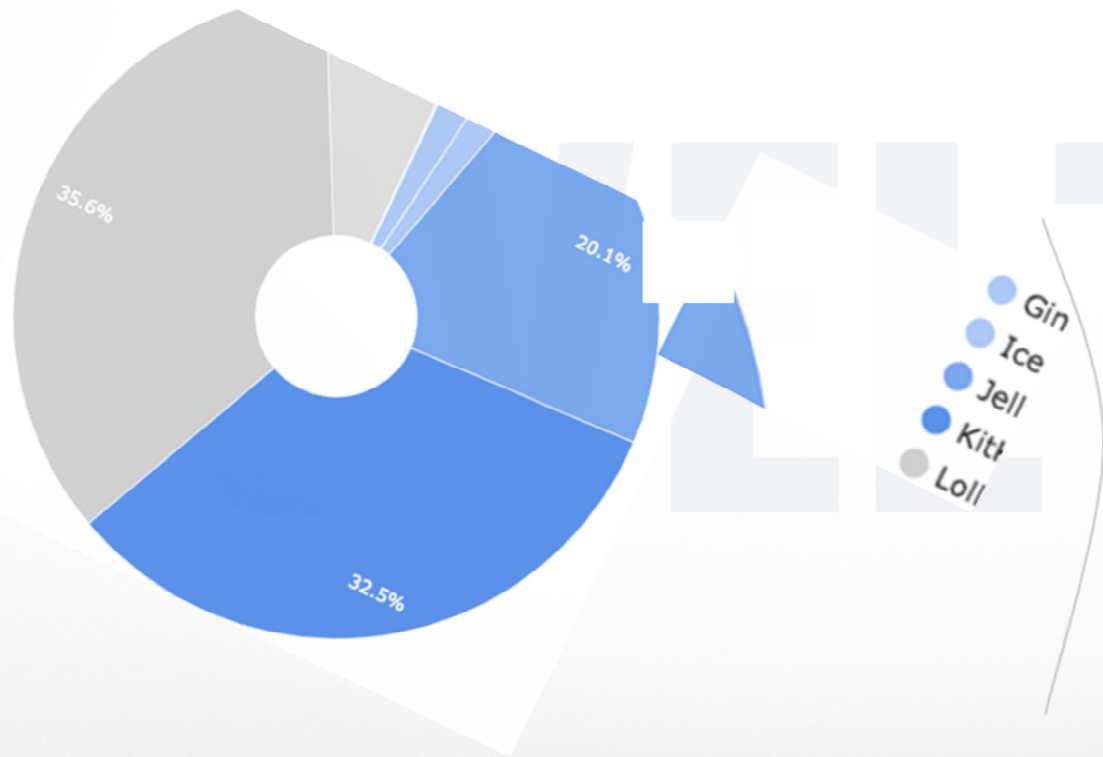
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~57% of all Android devices run **KitKat or lower** ...



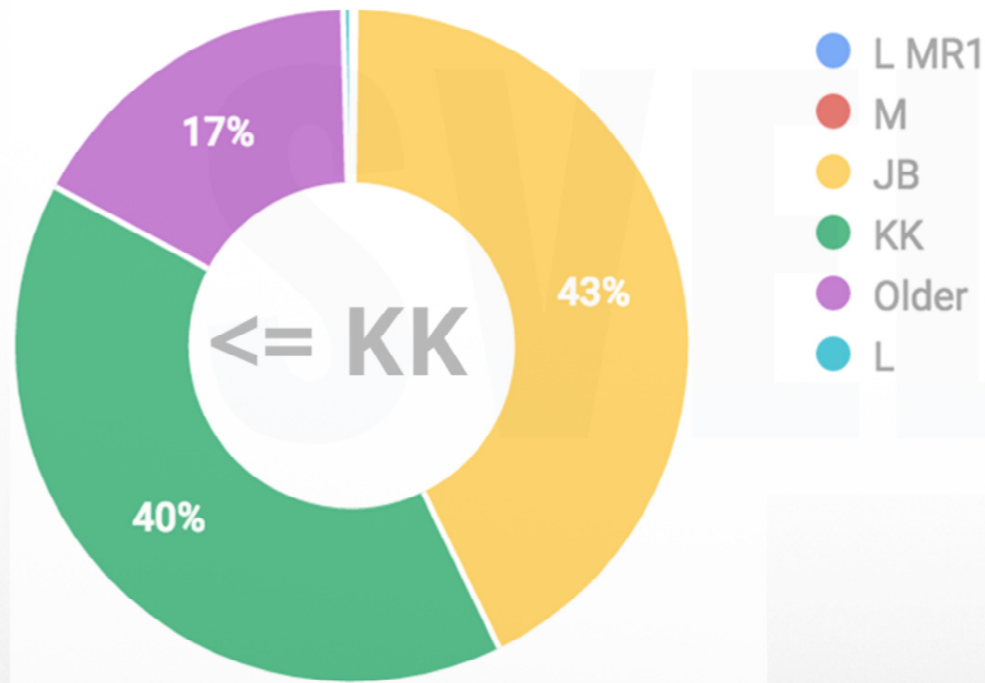
### Device OS Realities ...

- Device specs drive OS update adoption ...
- This means our 1P apps need to keep **backward compatibility** in mind ...

Sources: [Android Developers Platform Versions](#) ...

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~99% of Svelte devices are running **KitKat or lower** ...



### OS Realities on Svelte ...

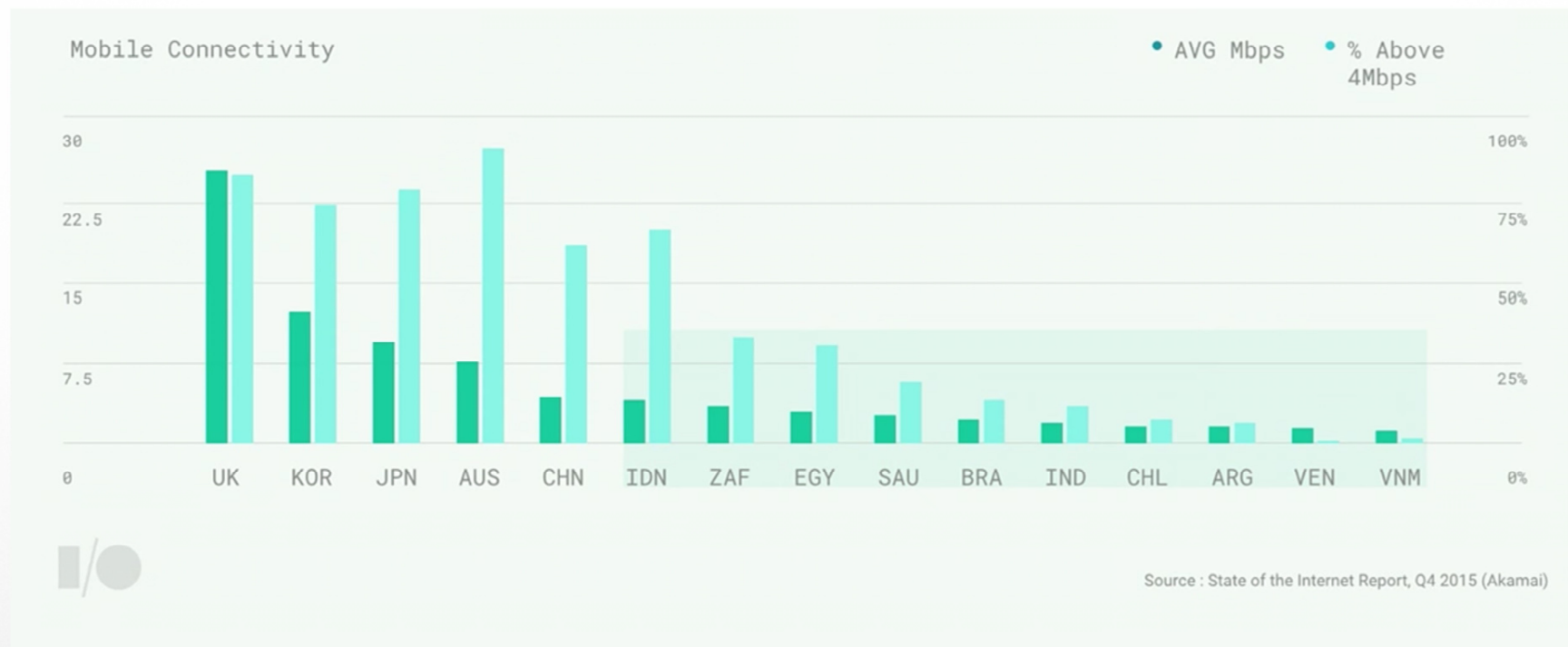
- Device specs drive OS update adoption ...
- Svelte devices still run best on KitKat or lower ...
- This means our 1P apps need to keep backward compatibility in mind ...

Sources: Svelte Actives Slices ...

Google Confidential



## Connectivity in the EM paltry ...



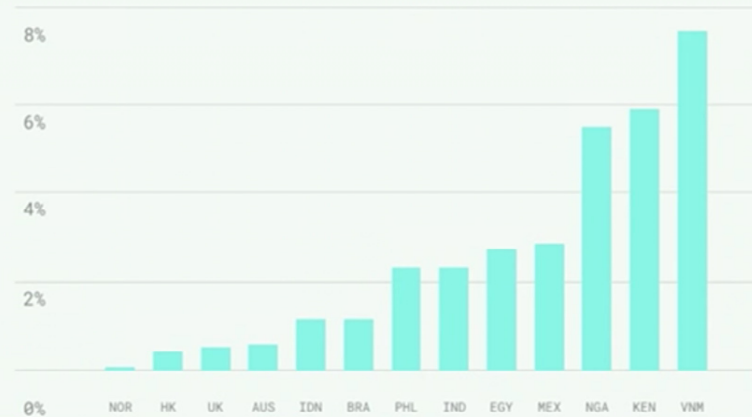
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## Cost of mobile connectivity high ...

Post paid data prices (% of per capita GNI)



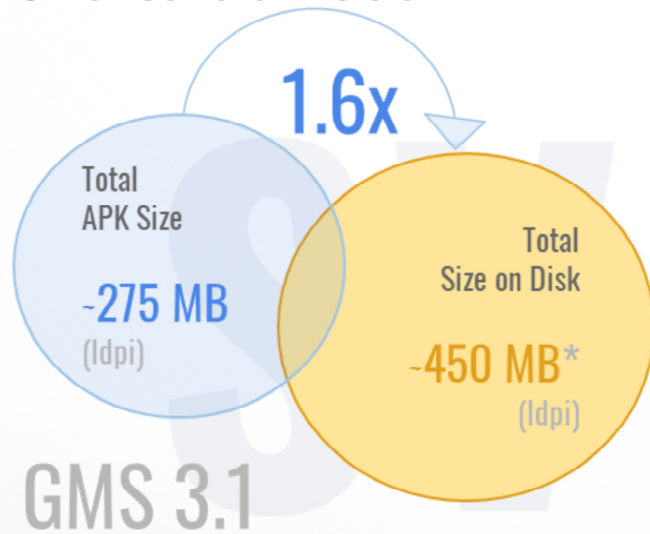
Post paid data prices (% of per capita GNI)



Source : Measuring the Information Society Report 2015 (ITU)

Google Confidential

## Reducing apps **on-disk size** and **APK update size** is critical on Svelte devices ...



\* Doesn't include Cache/User Data  
Source: [GMS 3.1 APK to Disk Size Ratio ...](#)

On a **2G** network, a  
**20 MB** APK can take up to  
**30 minutes** ...



Source: [How We Built Facebook Lite ...](#)

- **System partition space constrained** on Svelte devices ...
- **Expensive data + time needed** updating apps ...

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# RAM, On-Disk usage, and Data usage represent the core tenets of health on Svelte devices ...

## RAM

- ☐ Reduce # of GMS services in auto-start
- ☐ Reduce RAM usage of GMS apps/services

## Svelte Trifecta

## Data

- ☐ Reduce GMS apps' data usage/needs
- ☐ Reduce GMS apps' Play update size

## Disk Space

- ☐ Reduce pre-installed GMS apps on-disk size
- ☐ Reduce GMS apps' APK size

“The holy trinity”

Google Confidential

how are we doing on svelte?  
ram, disk, data budget proposals

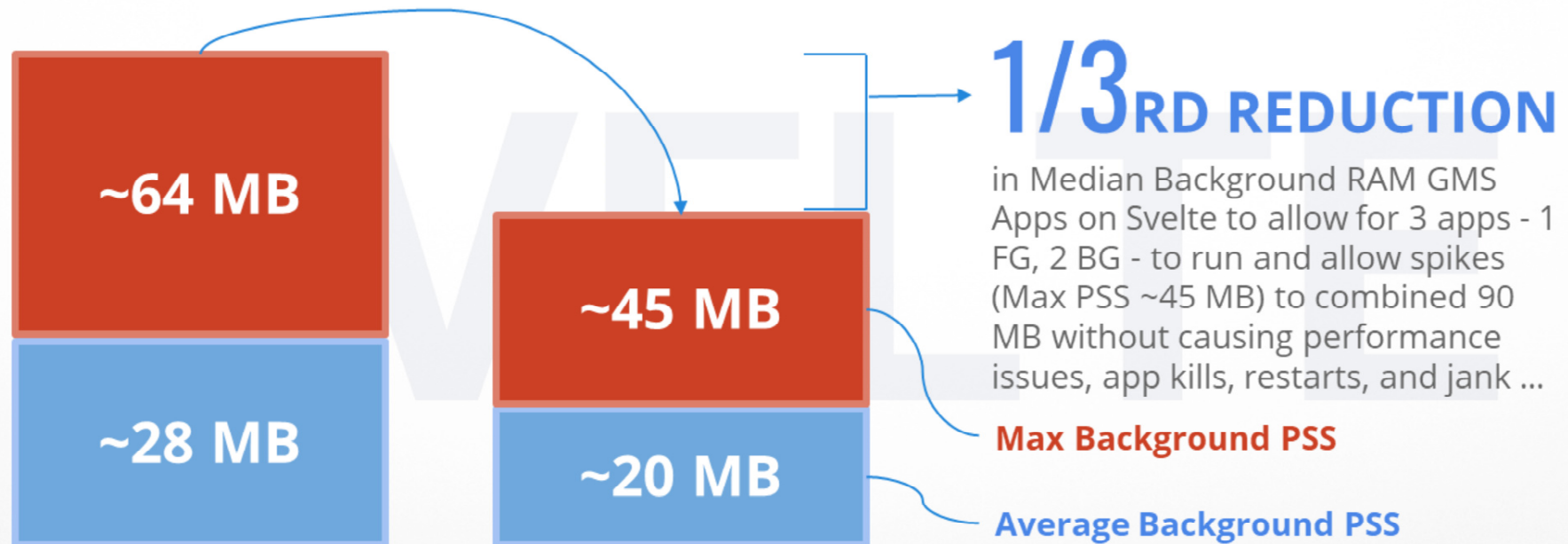
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**EXHIBIT 5963.R-039**

## RAM Recommendation : Reduce BG RAM by 1/3rd ...

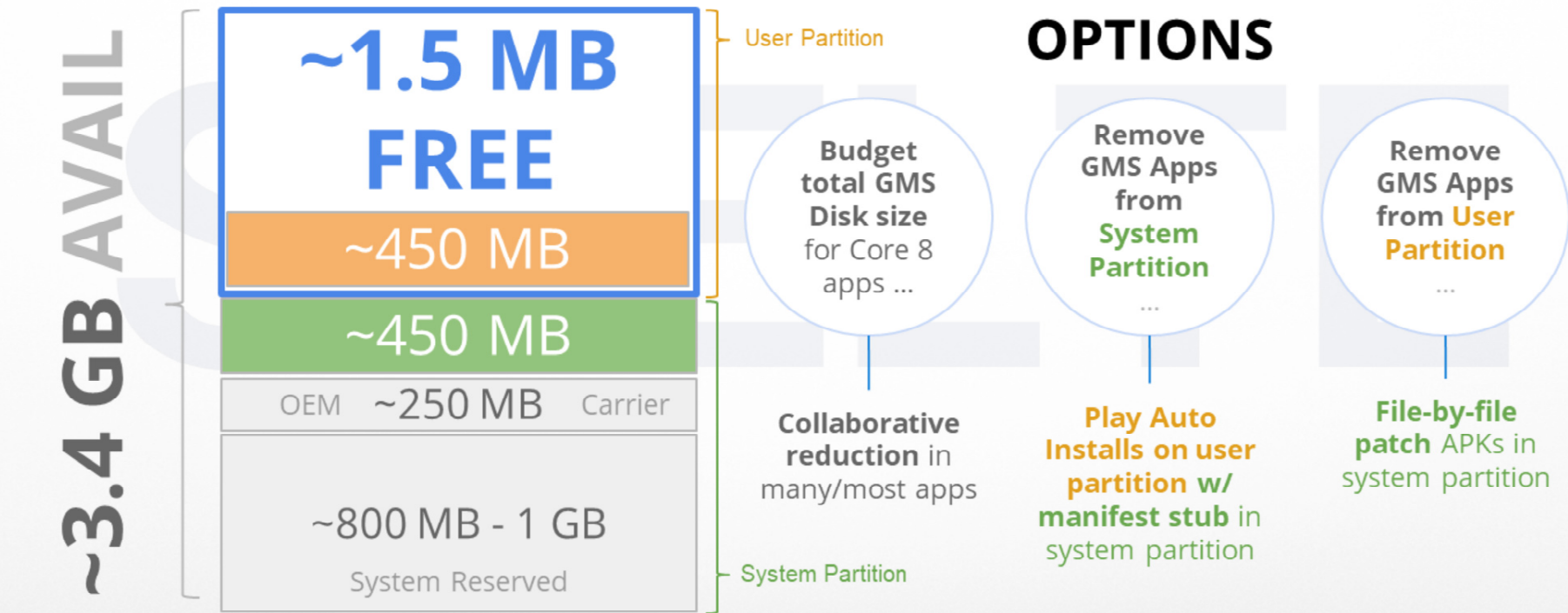


Let's allow Svelte users to run at least 3 GMS apps stably and continuously to ensure an acceptable user experience...

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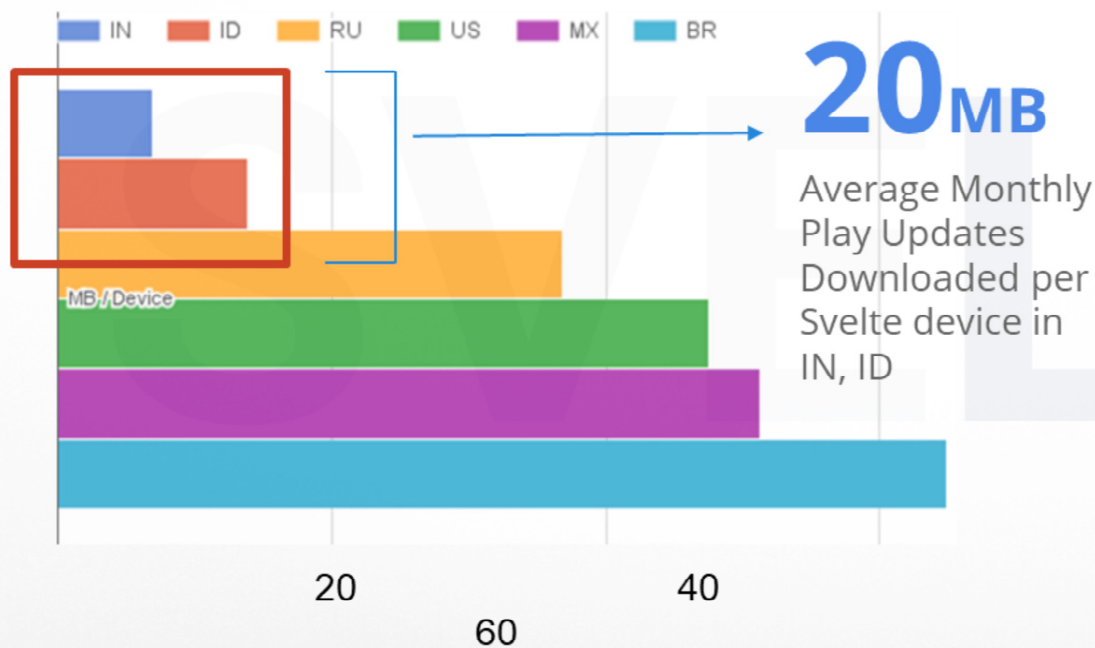


# Storage Recommendation : Cut duplicated 450 MB ...



Google Confidential Sources: Smart Stubs and Pre-Caching; LG D105 Specs; MDPI Disk Space Usage; Patching System APKs; Removing GMS Apps from the System Partition ...

## Data Recommendation : Cap Monthly GMS Update to 20 MB for Svelte dominant regions ...



→ This means a Svelte device in **India, Indonesia, Russia**, and similar EM countries **downloads a fraction (20 MB average) of the ~145 MB of available monthly Play Updates** for the core 8 GMS Apps, and is **consistently and significantly behind in recency of updates** when compared to countries with much higher Wifi availability

Google Confidential MBs / Active Device

Sources: Play GMS Apps Updates Analysis (30 data data) ...

# memory on svelte

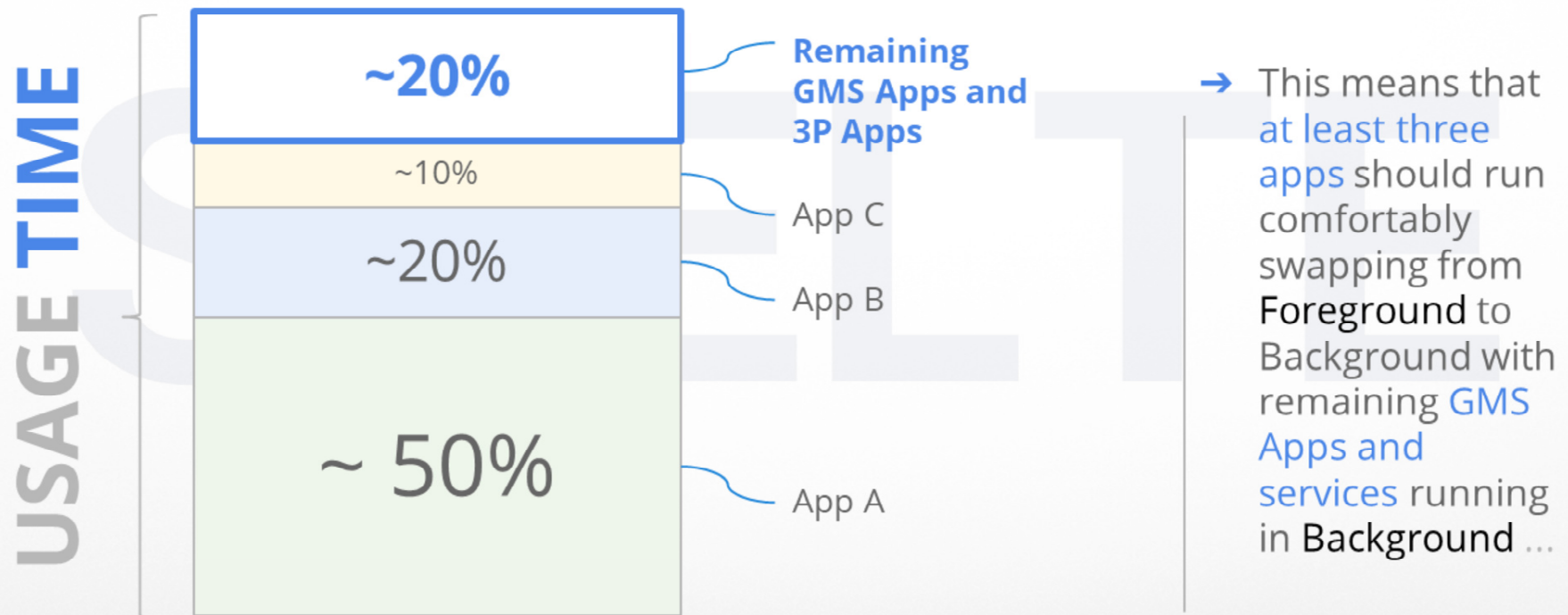
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GOOG-PLAY-003687175.R

**EXHIBIT 5963.R-043**

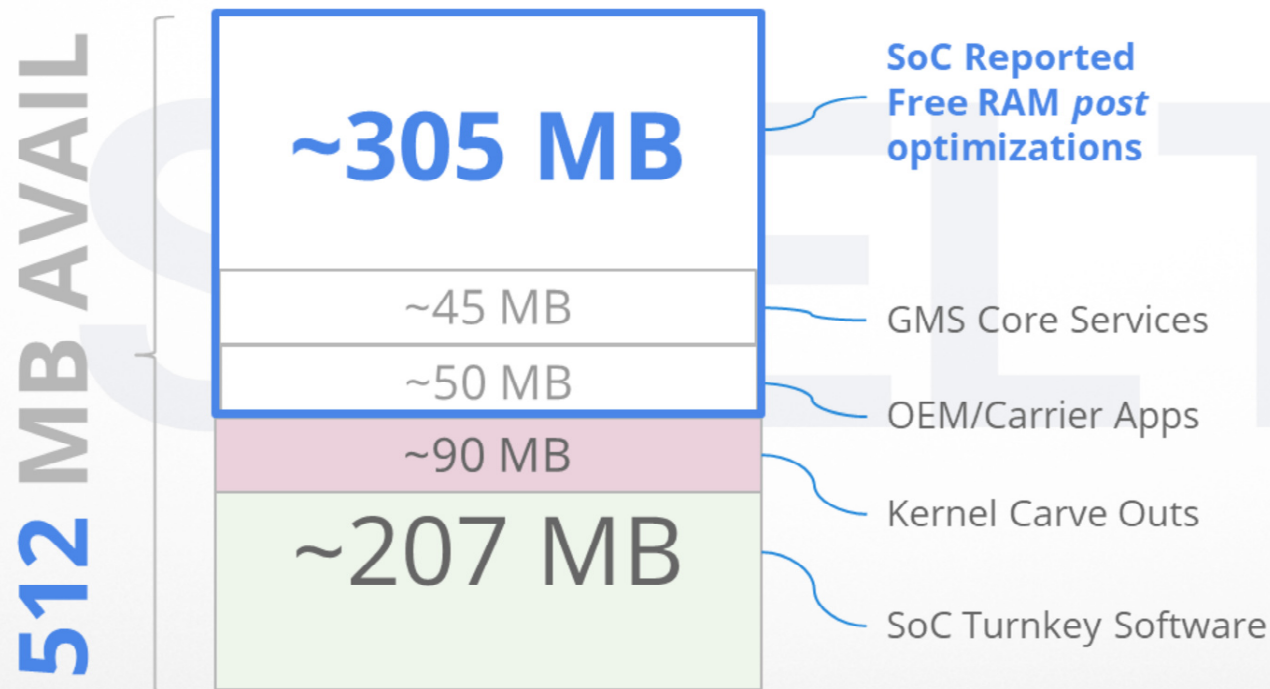
## Typical Smartphone: 3 Apps used 80% of the time ...



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Sources [This is How Many Apps ..](#)  
[ComScore 2015 Apps Report](#)

## Typical Svelte Devices: ~300 MB max Free RAM on M ...

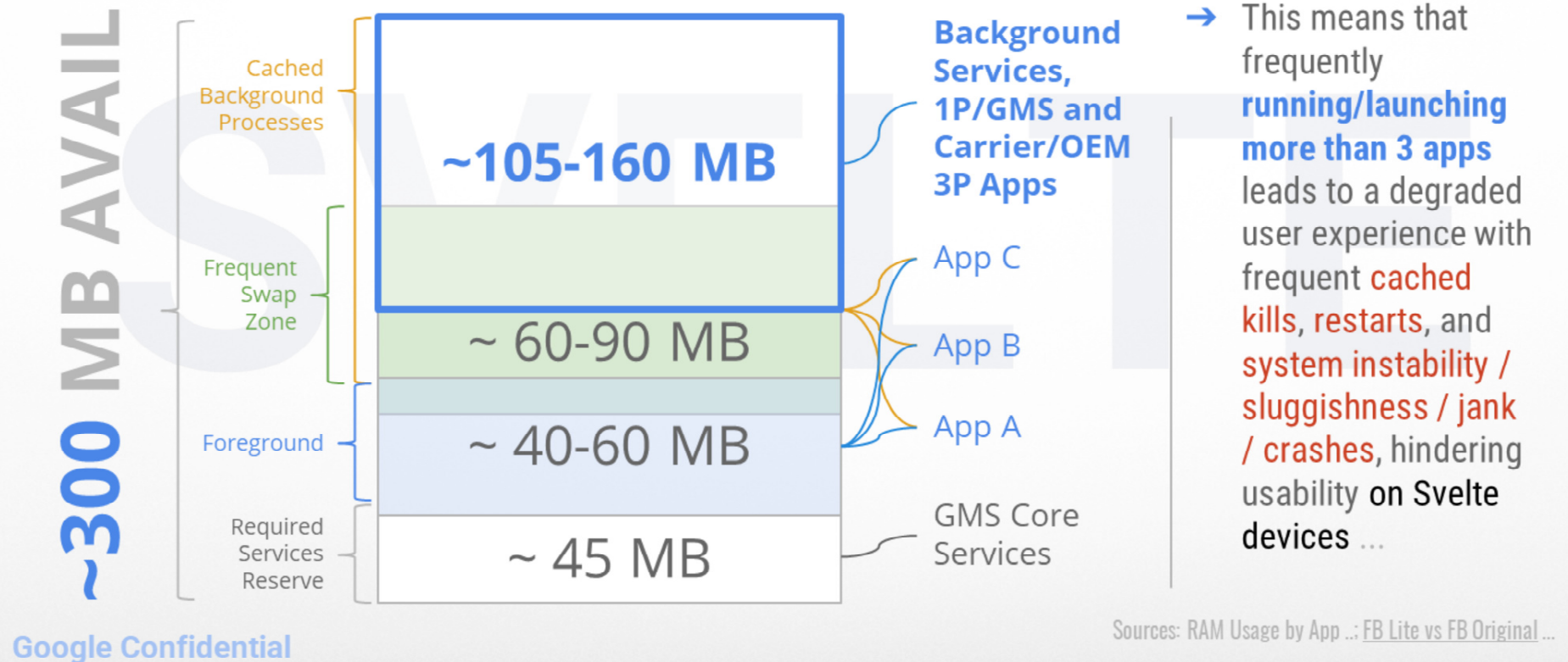


→ This means ideally, GMS Core and all 8 GMS Apps and a few popular 3rd Party Apps running in the Foreground and Background need to play in the space of ~165 MBs ...

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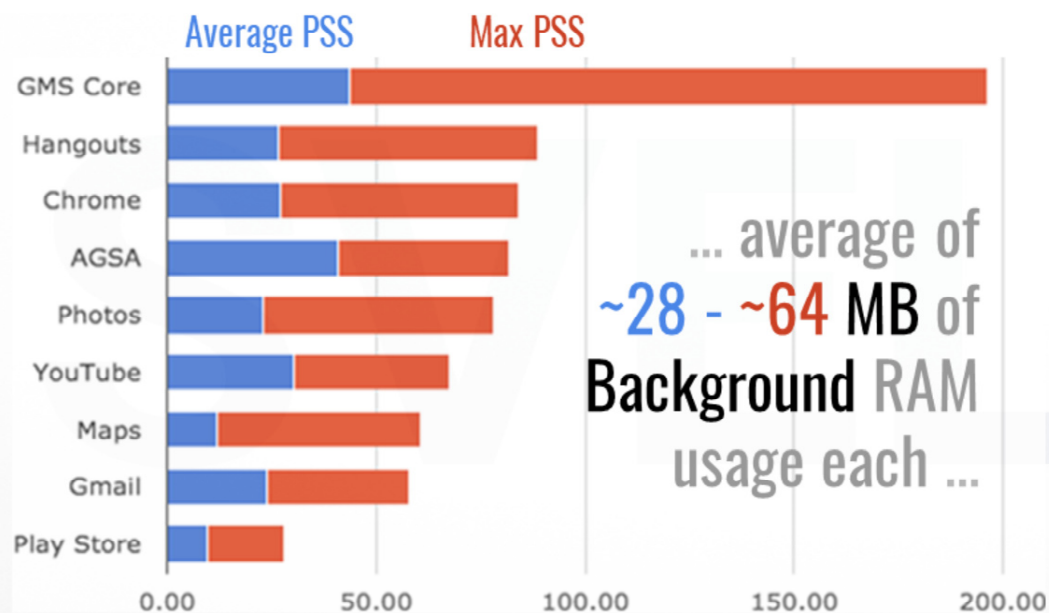
Sources MTK 512 MB Update ..

# GMS apps have ~100-160 MB in free RAM to run in BG ...





# However, GMS Apps' background RAM use is often much higher - A Tragedy of Commons ...



→ This means that **frequently, any 3 or more apps** (along w/ GMS Core) running on a Svelte device **result in jank, sluggish performance, and trigger app kills/re-launches**, degrading user experience ...

... on a device with **~100-160MB** of max free RAM avail ...

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Source: GMS Procstats Average and Max RAM Usage ...

storage on svelte

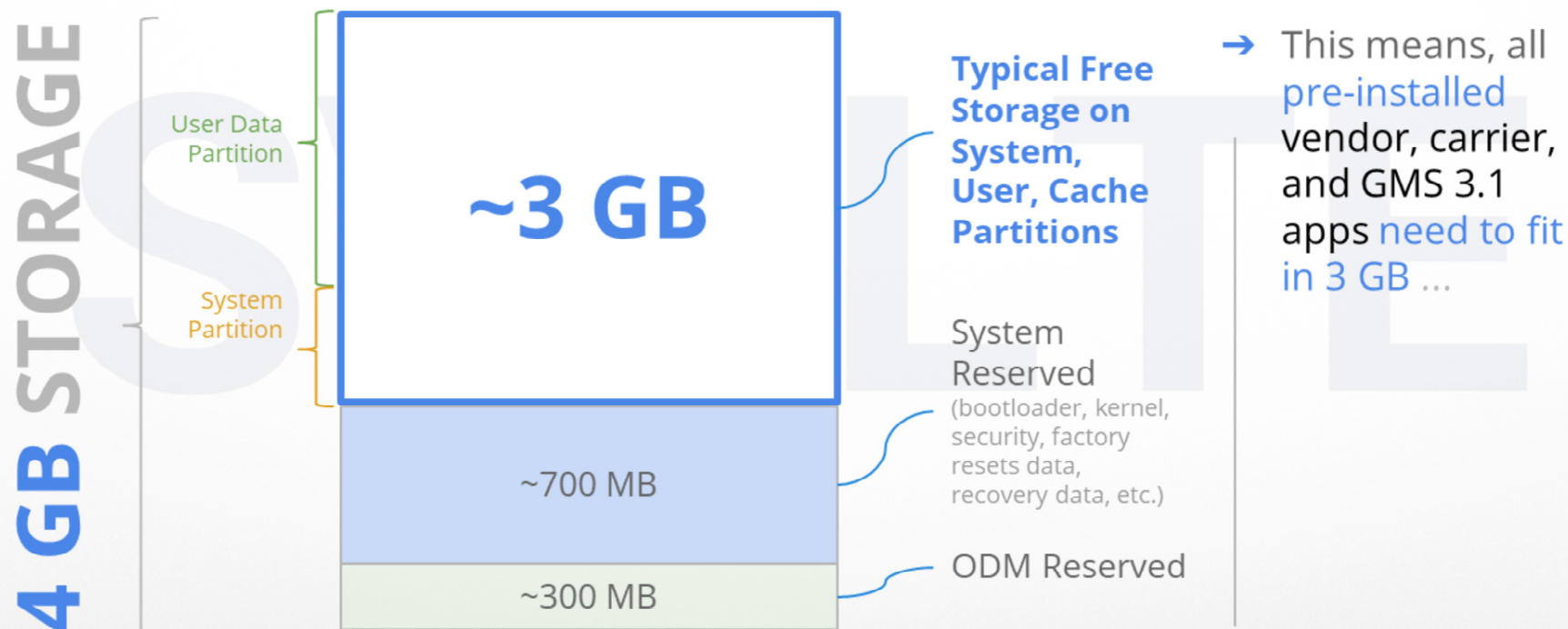
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GOOG-PLAY-003687180.R

**EXHIBIT 5963.R-048**

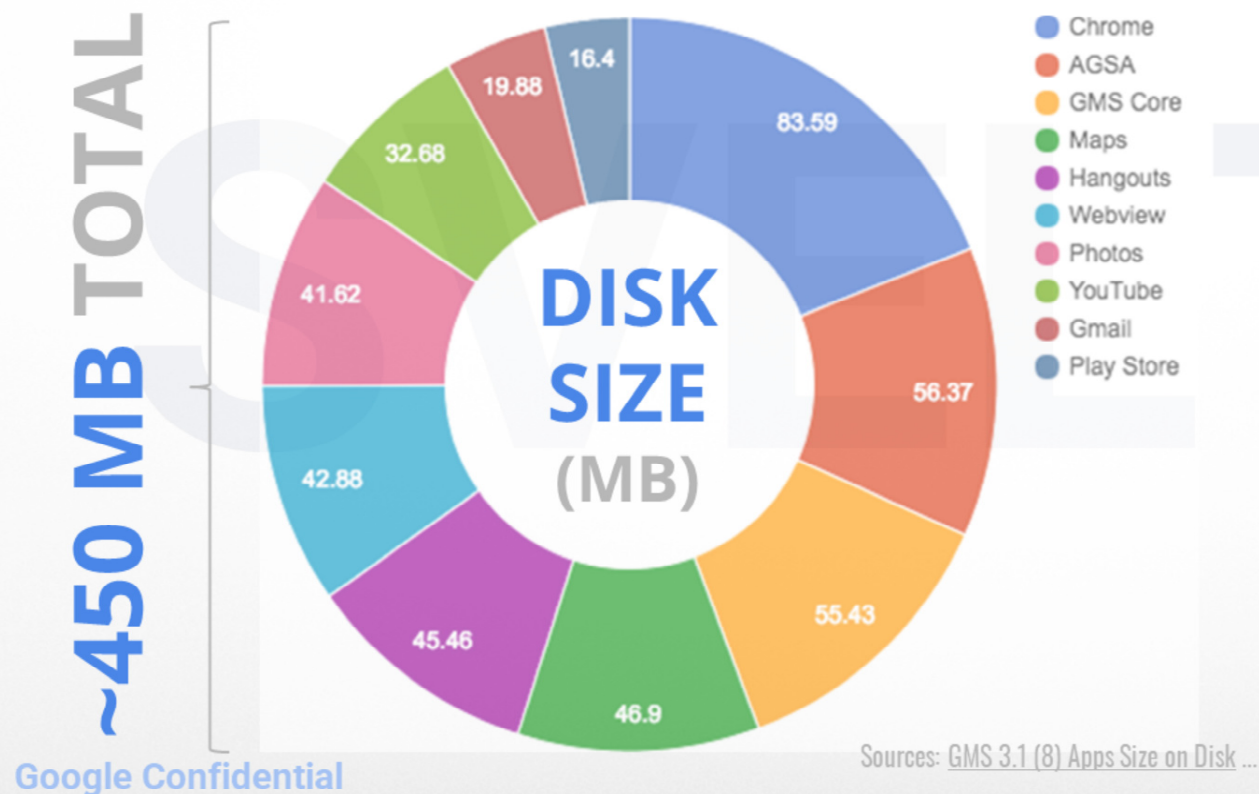
## Typical 4 GB Svelte Devices: ~3.5 GB storage useable ...



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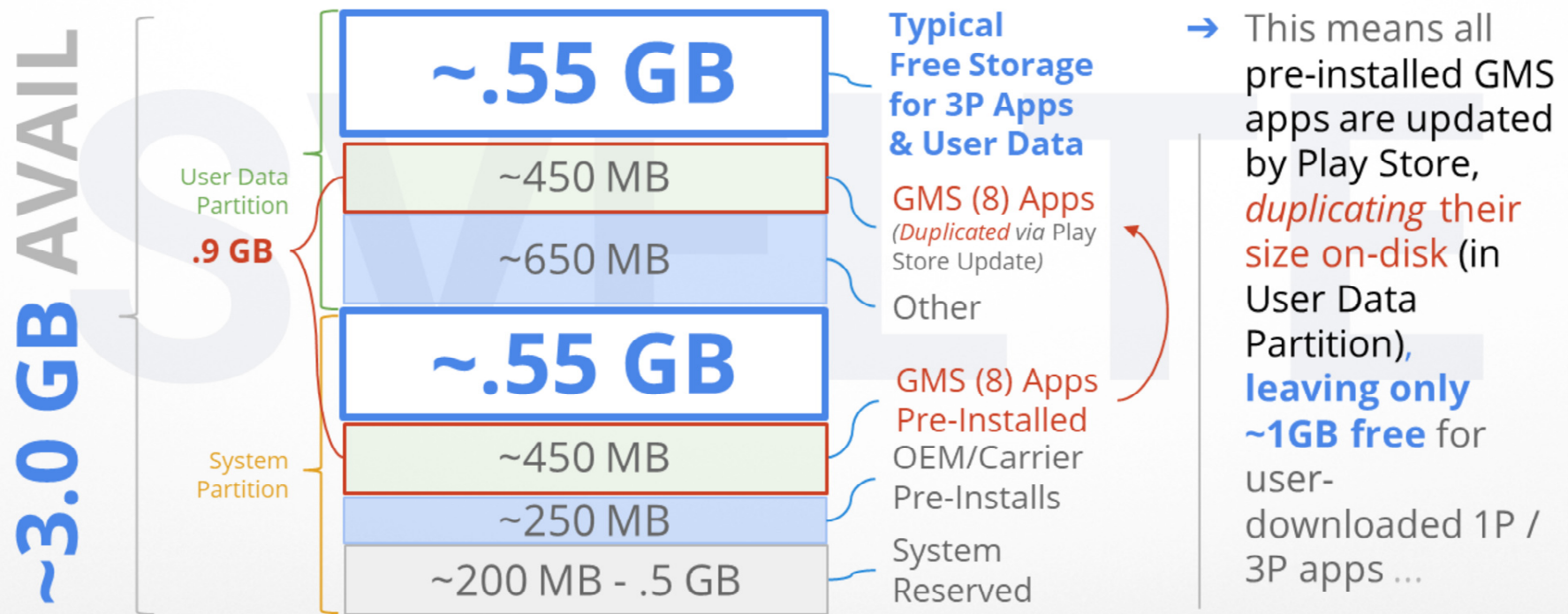
Sources: [LG D105 Specs](#); [MDPI Disk Space Usage ...](#)

**GMS Apps Size on Disk** on a Svelte Device are **~450 MB**,  
**multiplied x2** onto User Partition to almost **~1 GB** ...



→ This means typically, a Svelte device, of the **3.5 GB of space available** for pre-installs, almost **~1GB is taken by GMS** ...

# Only ~.55 GB free after ~1 GB of GMS and 3P Apps ...

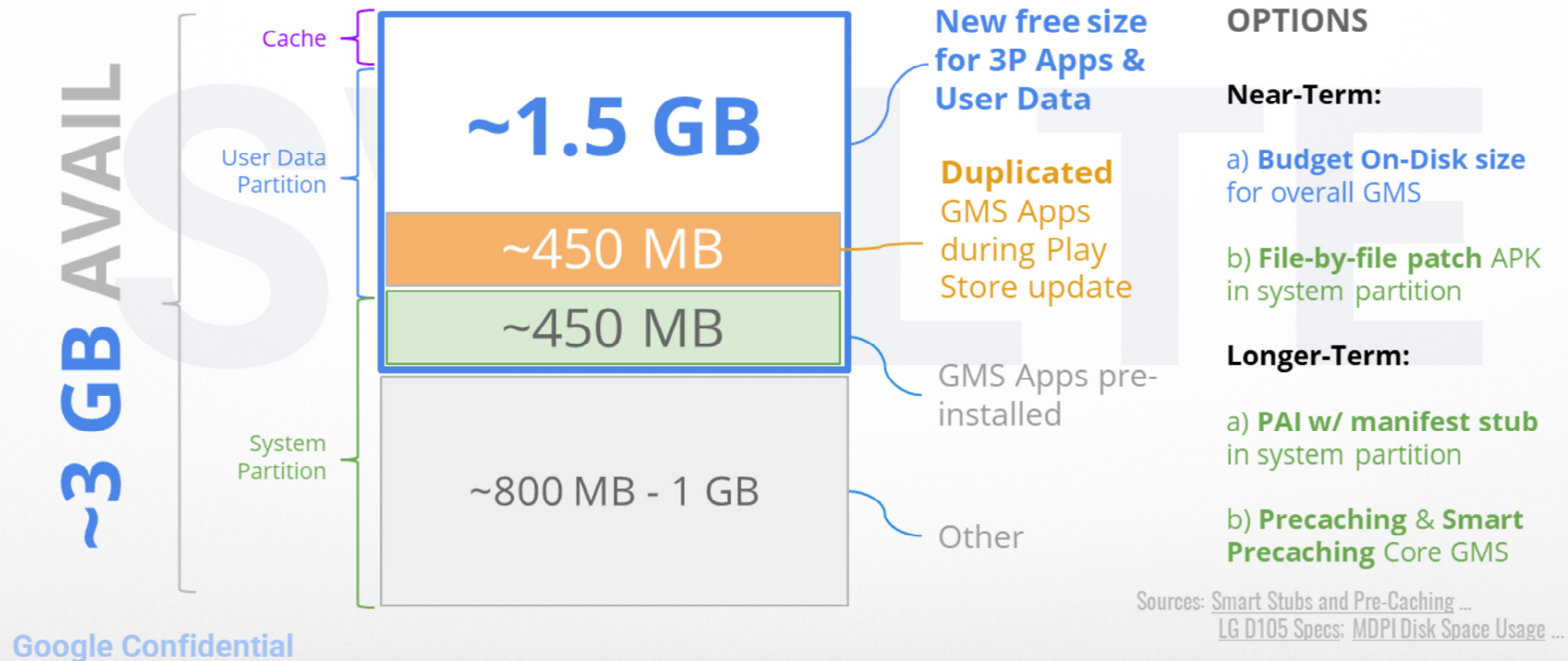


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Sources: LG D105 Specs; MDPI Disk Space Usage ...



# Storage Recommendation : Cut duplicated 450 MB ...





## ~1 GB free storage on Svelte is **insufficient** for users ...

93%

**Transfer content** like Photos, Videos, and contacts to another device ...

75%

**Use SD Cards** for extra storage needs on their device ...

### Common Workarounds ...

- Delete content on phone
- Transfer to SD card, flash drive & other devices
- Use web apps instead of native apps
- Run optimization app
- Email content to self, or 'keep safe' on Facebook, Instagram, or YouTube

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Sources: Project Chegar Desk Research ...

data (bandwidth) on svelte

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**EXHIBIT 5963.R-054**

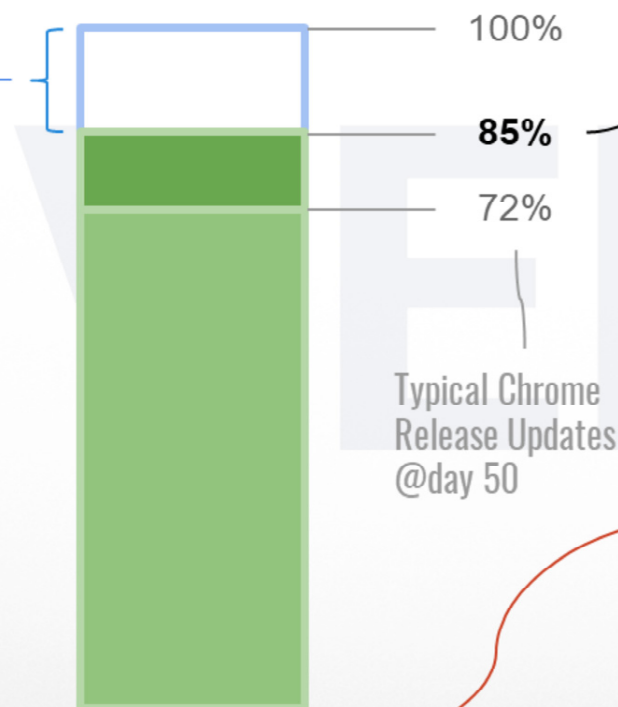
# Global app update rate max of ~85% of app installs ...

## Key Svelte regions: much lower rate due to Wifi/Disk ...

# 15%

Minimum global app staleness due to factors *outside* of Play Store restrictions ...

**This % is much higher in key Svelte regions.**



Chrome M47 'Flag Day' Release @day 50 ...

Chrome was auto-updated by Play Store as soon as staleness was detected, **w/o usual restrictions**:

- Not on wifi
- Low on disk
- Network errors
- Disabled by user
- Auto-update disabled for app
- Foreground app

Sources: [Play Team: What is Update Rate?](#) ...

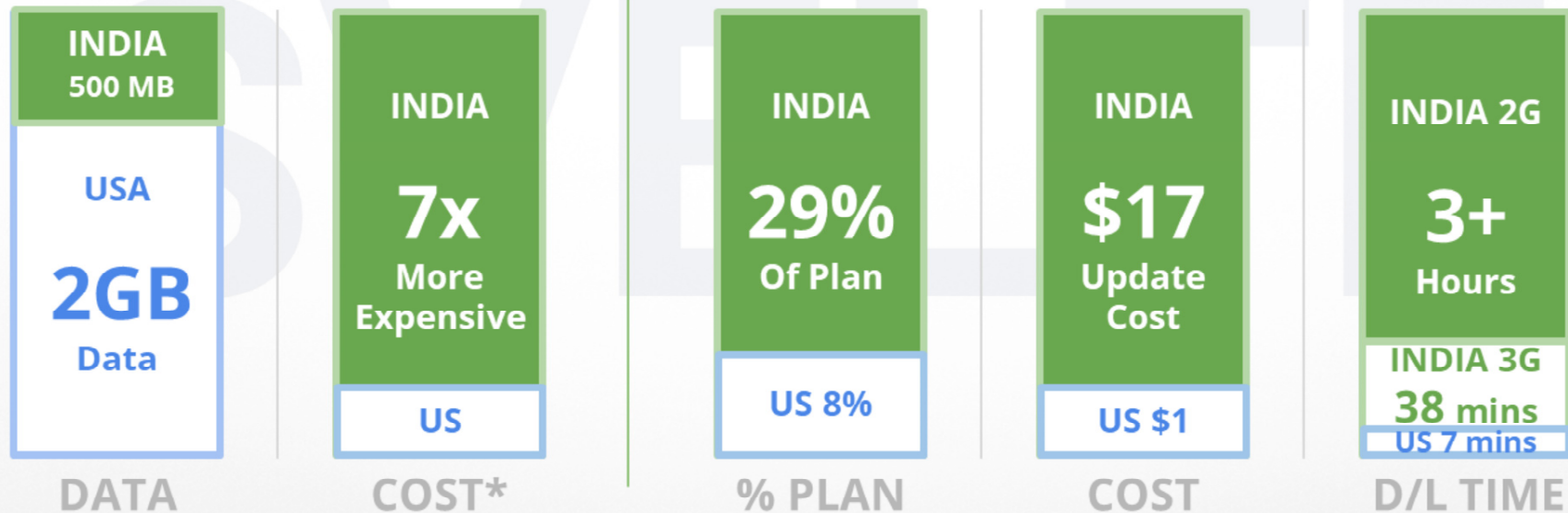
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# What if we encouraged updates over Cellular? ...

## Key Svelte regions: monthly cellular update *expensive!*

### MONTHLY PLAN

**145 MB : 8 APP GMS UPDATE/MO.**



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\*Using relative monthly income

Sources: [GMS Update Comparison - India vs US ...](#)

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EXHIBIT 5963.R-056

## Ideas for increasing Play Update Rates in Svelte Regions : Update Play Store Restrictions ...

Reduce min 500 MB avail required to 400 MB (10% of 4GB) for Svelte and **update free disk check algo** to not include APK patch and existing APK in calc ...

**CHANGE  $\geq$  500 MB DISK SPACE REQUIREMENT**

Change requirement where 'Wifi Only' Auto-Updates currently also require device to be plugged into power to instead  $\geq$  50% power ...

**CHANGE WIFI + POWER REQUIREMENT**

Throttle and **prioritize updates** based on User on-device usage #s for Core GMS apps on Svelte Devices based on device region/network ...

**THROTTLE AND PRIORITIZE UPDATES**

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## New thinking also needed to keep Svelte users running latest, lite 1P apps ...

(Westinghouse /  
Instant Apps)  
Modularized,  
Disk/RAM efficient,  
lite 1P app  
modules instantly  
installed/run while  
web browsing -  
also on cellular ...

### EPHEMERAL SVELTE APPS

Develop separate /  
decoupled Lite  
Apps for Svelte ...  
FB RAM <= 40 MB,  
APK <= 15 MB ...  
Use Play Svelte  
targeting to  
manage Lite app  
updates ...

### LITE VERSIONS OF APPS

GMS teams could  
work with  
Spacecast and  
similar efforts to  
allow for updates  
which require no  
wifi or cellular  
service - most key  
Svelte regions /  
BRIIM ...

### INNOVATIVE DISTRIBUTION

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Sources: ...



why size and relevance matters

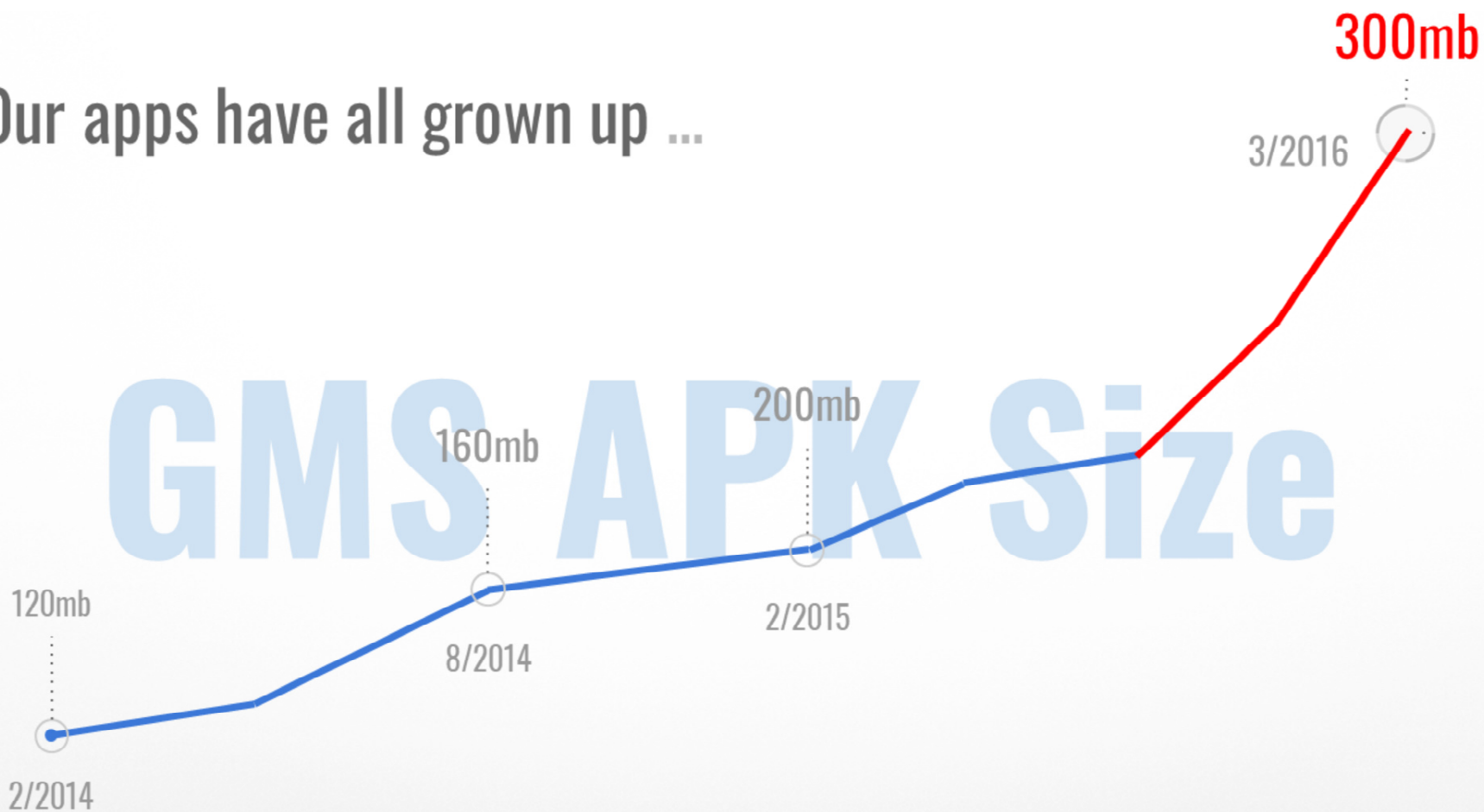
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**EXHIBIT 5963.R-059**

Our apps have all grown up ...



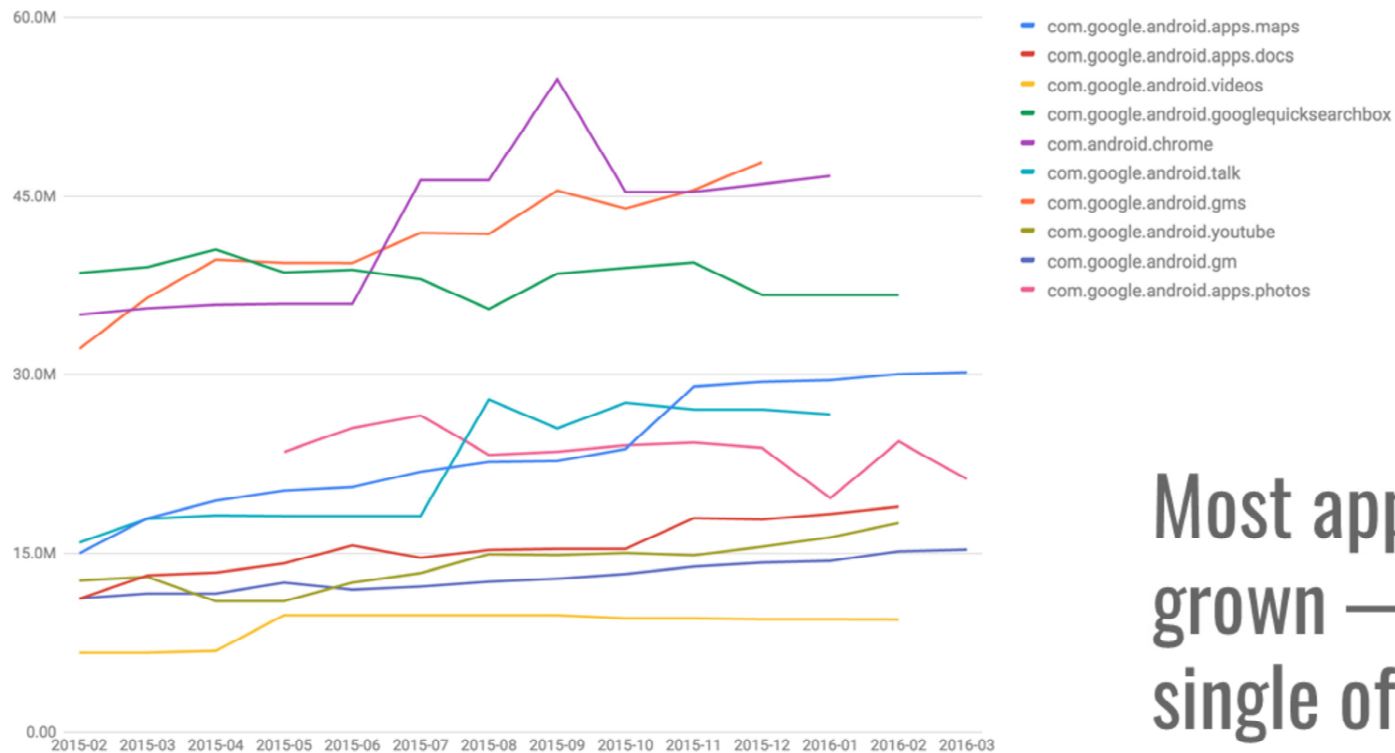
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EXHIBIT 5963.R-060

# Median GMS App **APK Size** has steadily risen ...



Most apps have  
grown ——— no  
single offender ...

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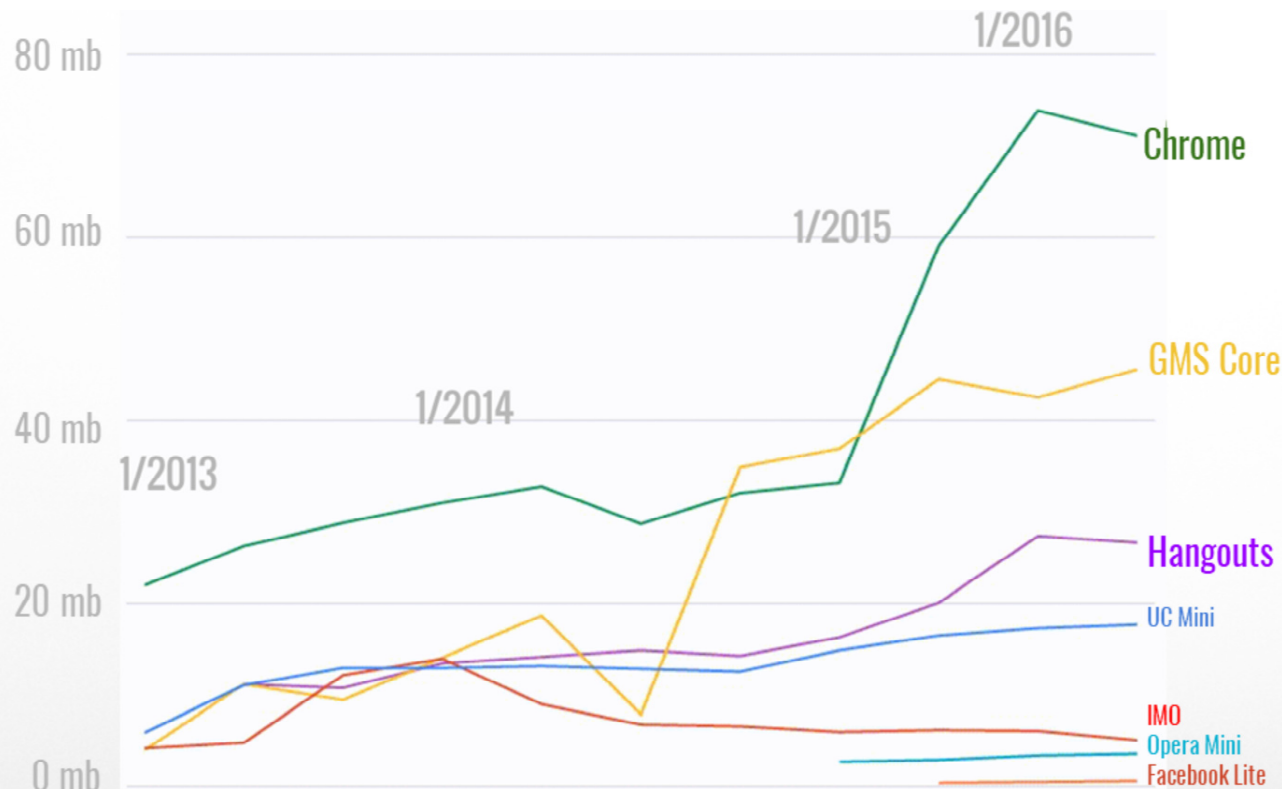
Slide 59

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- 1 Teddy Wondwosen@google.com is there a dash for this data?  
Samer Sayigh, 7/19/2016

# Our competitors are building *Lite* apps ...

"FB Lite hits 100M Daily Users ..."  [Source.](#)

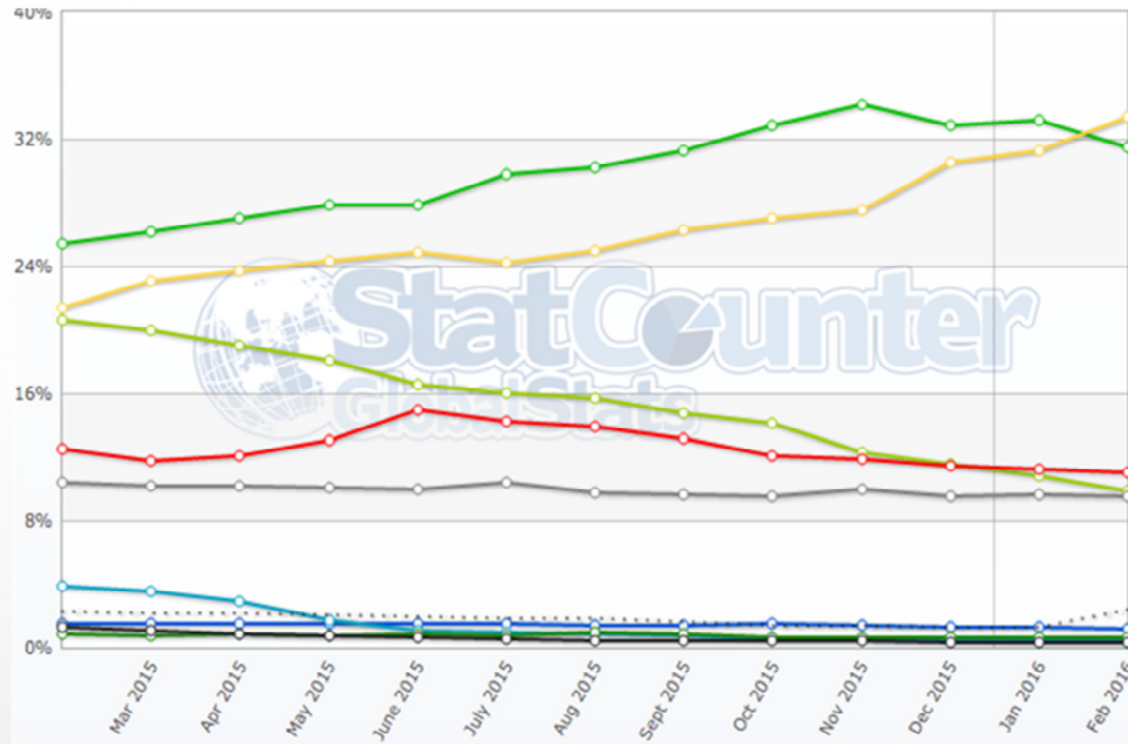


GMS Apps Zone:  
**20-80mb**

*Lite* Apps Zone:  
**0-15mb**

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... and they're starting to move ahead of us ...



UC Browser  
Chrome

## Top 9 Mobile Browsers in Asia

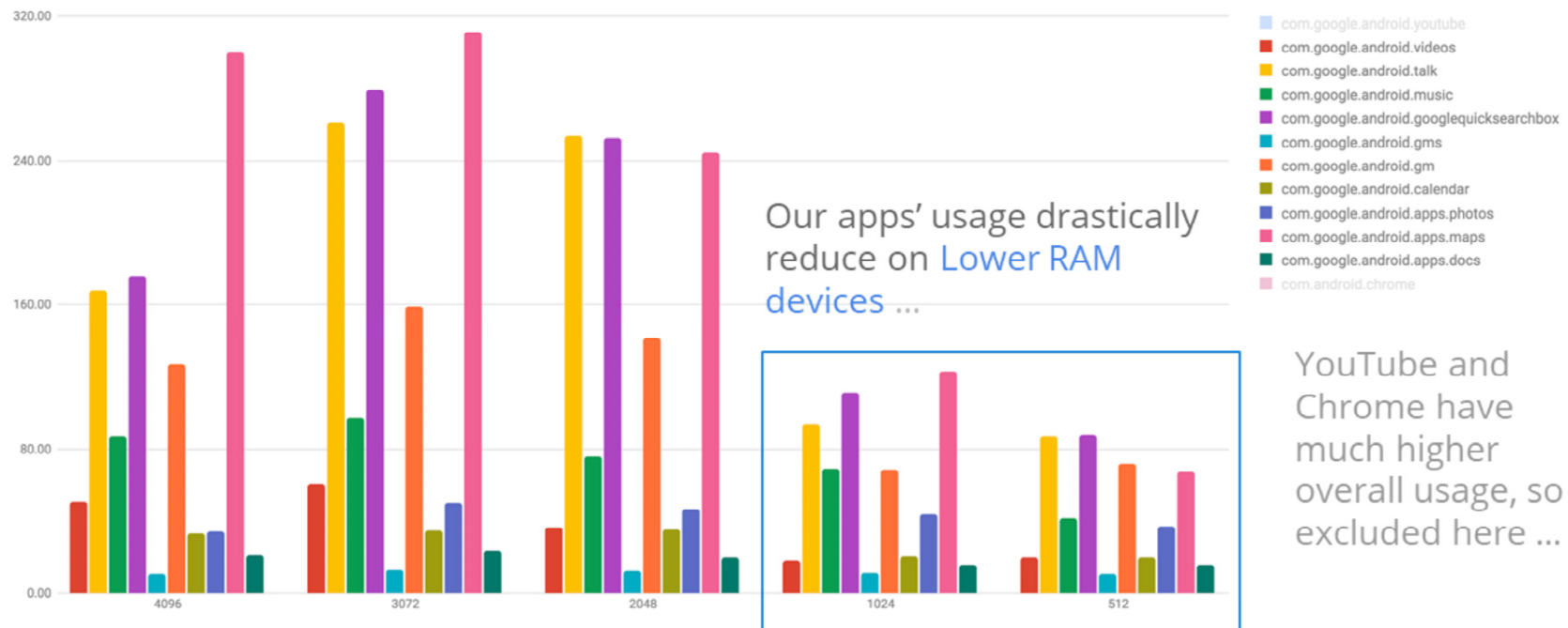
Source: StatCounter Global Stats

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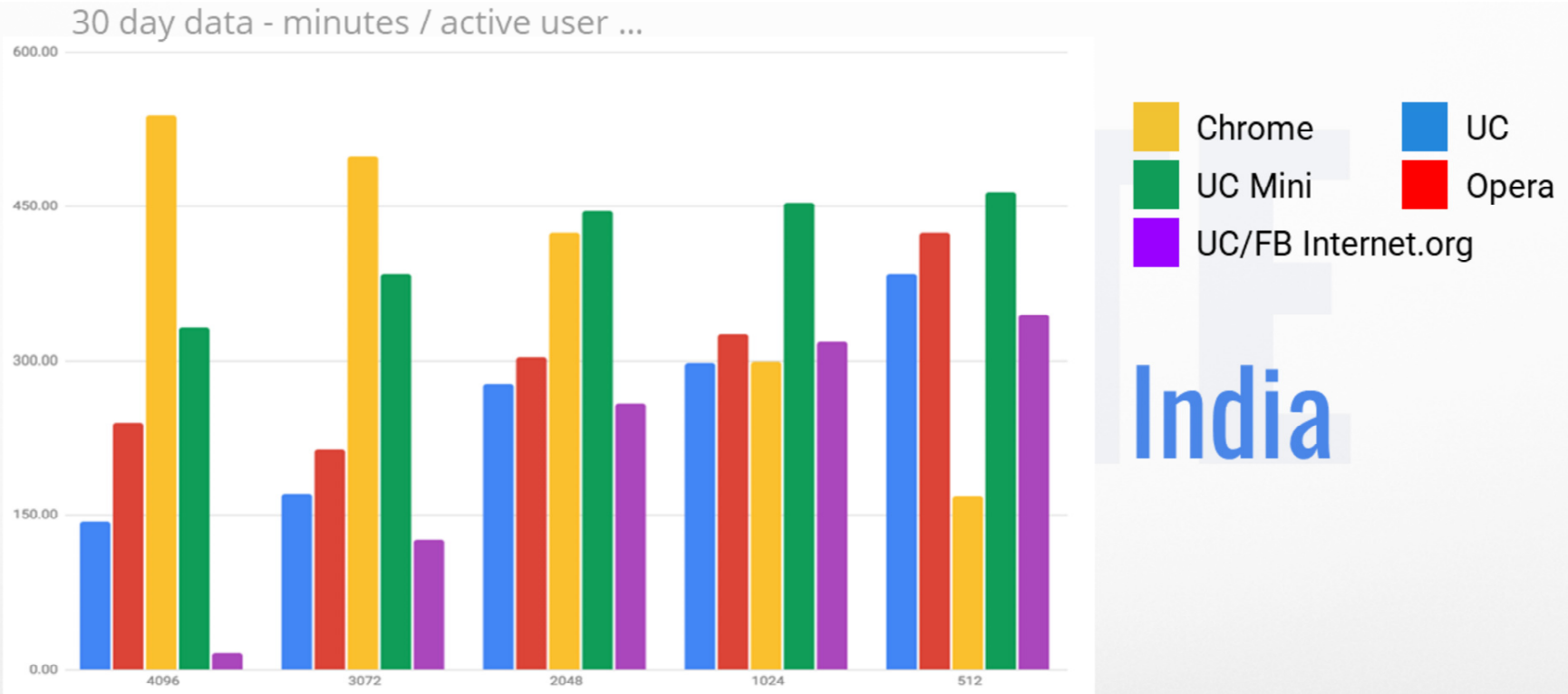
# GMS on Svelte : App usage (min/user) Lags ...

30 day data - minutes / active user - all countries combined usage ...



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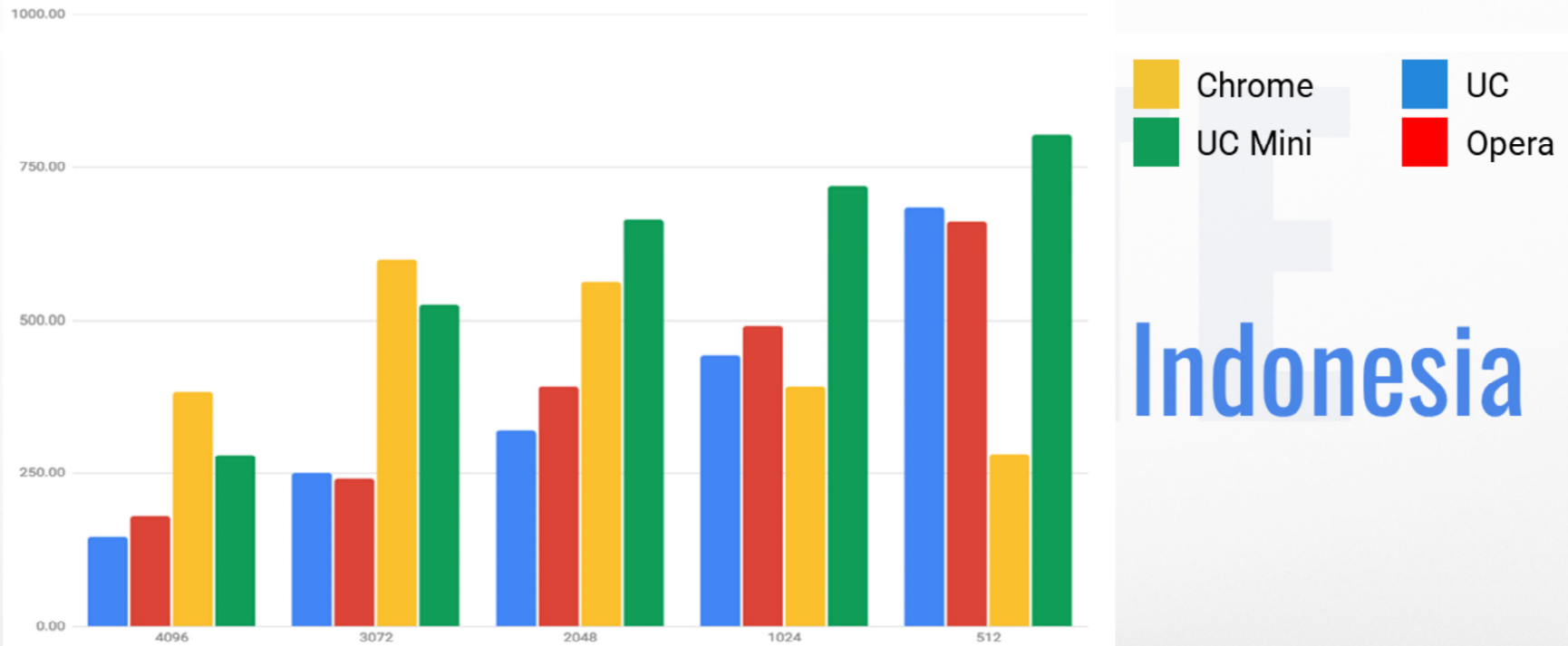
## The Lite Effect : Lite browsers dominate @ 512 MB ...



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## The Lite Effect : Lite browsers dominate @ 512 MB ...

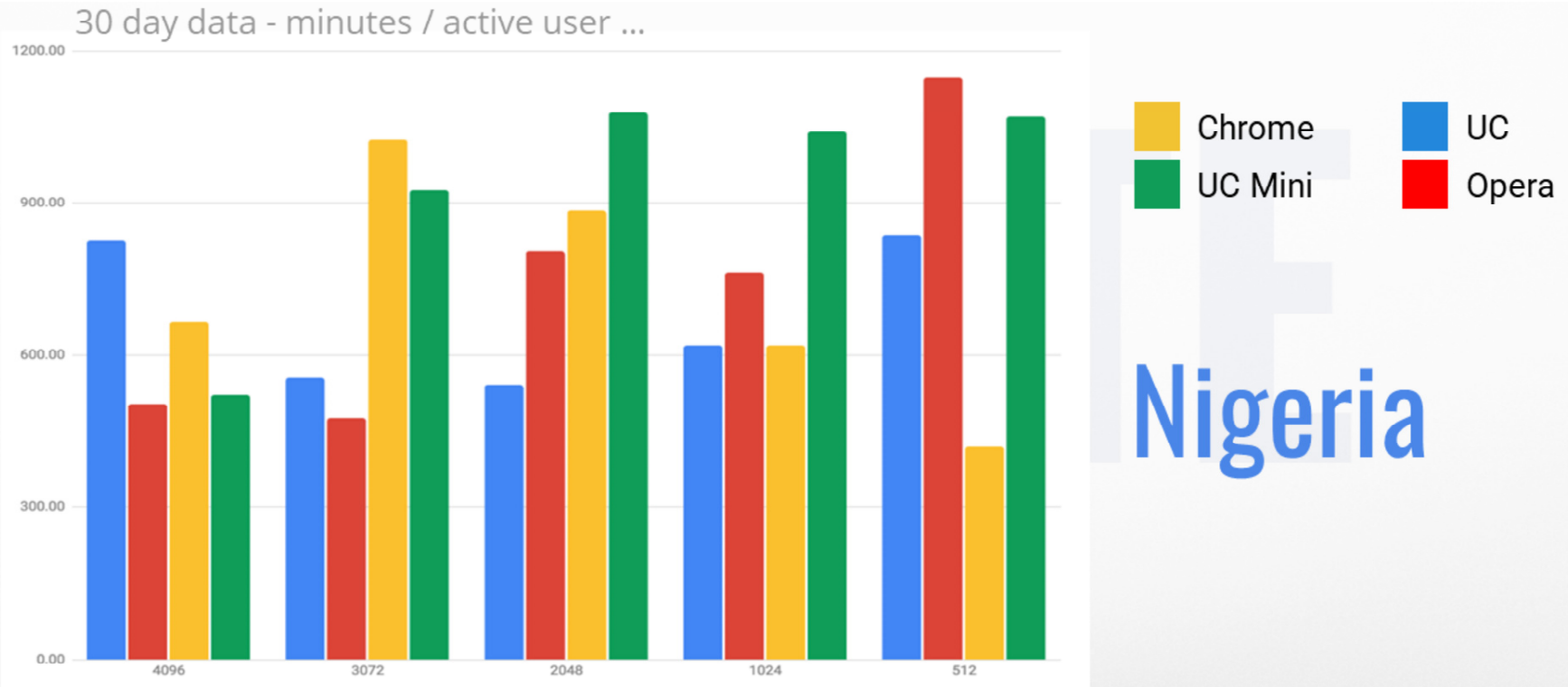
30 day data - minutes / active user ...



Indonesia

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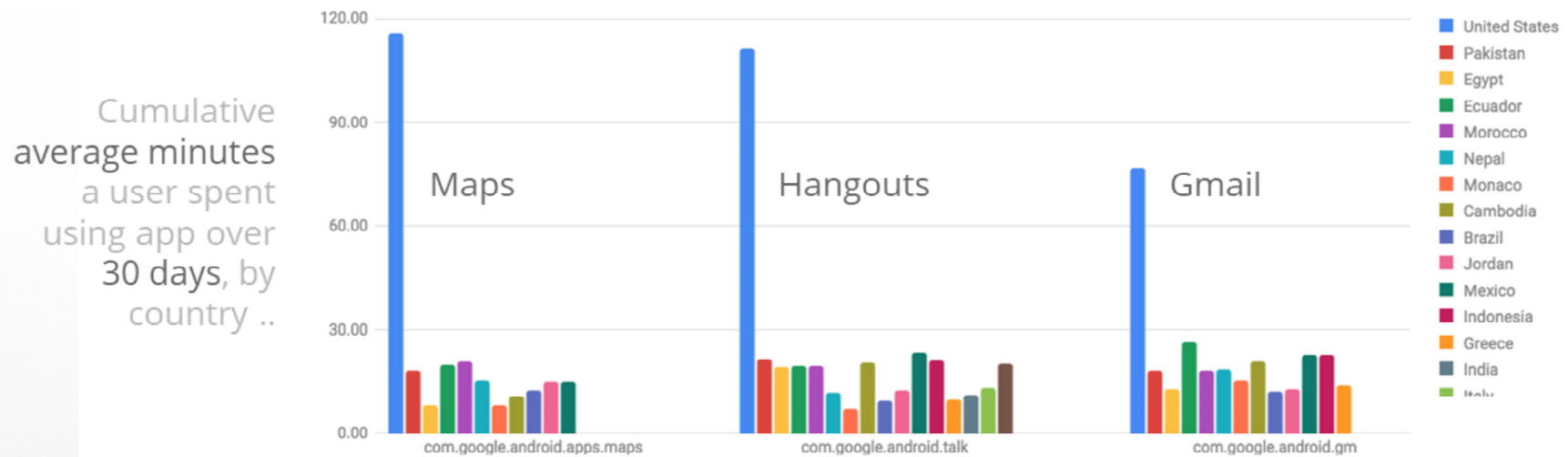
## The Lite Effect : Lite browsers dominate @ 512 MB ...



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## Relevance matters, too: Usage paltry in some EMs ...

App Usage Minutes on Low RAM Devices — 30 Days (average minutes/user)



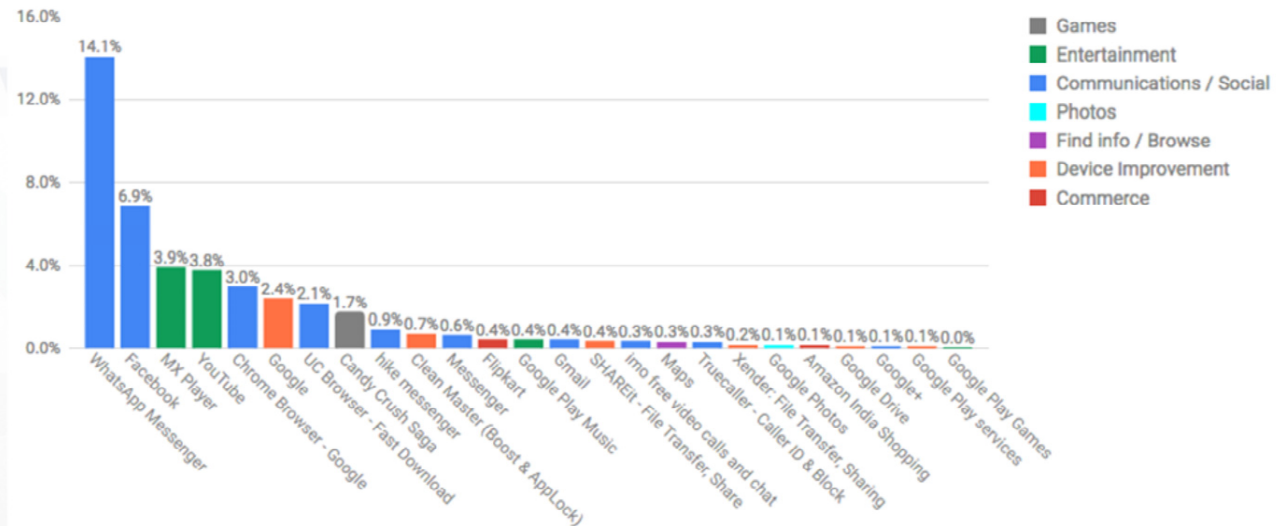
... some Main app's average usage in EM 3 - 5x+ less than in US ———  
 low risk of experimenting w/new, locally relevant lite app versions ...

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## India: Competitors have 2x share of usage minutes ...

Time spent: Share of weekly time (mins.) spent by 7DA - top 25 apps (% share)

% of time a users spent using apps over 7 days, for top 25 apps in India, representing almost 50% of all usage time on device ..

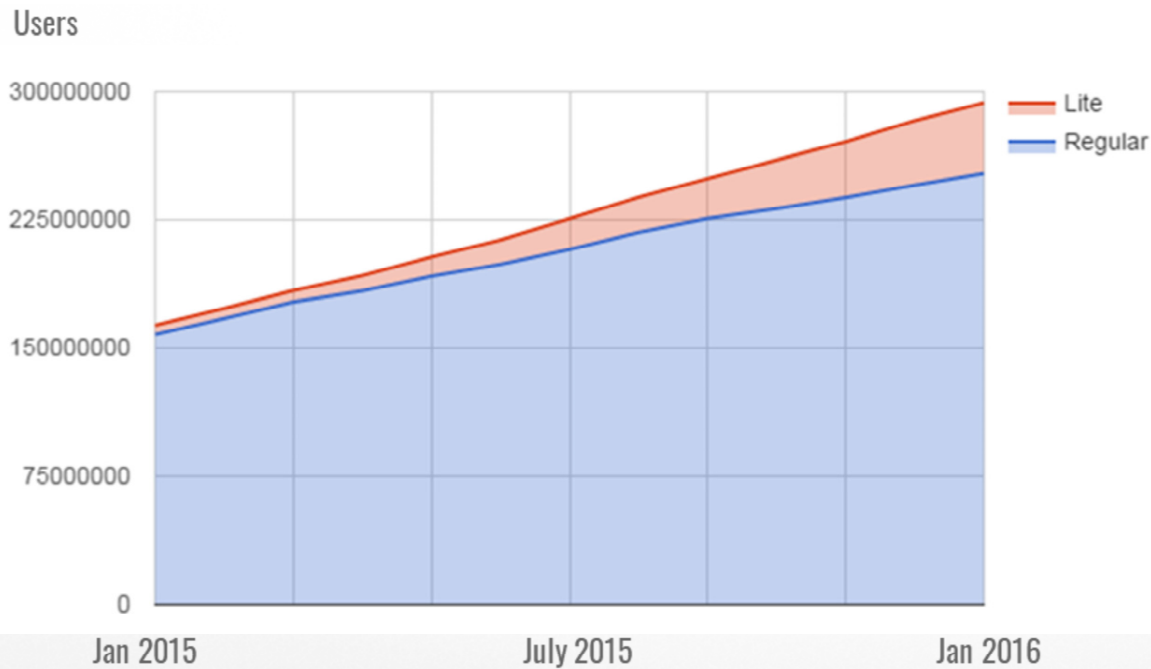


... In top 25 apps in India, Google apps have 11% share, while competing for same use cases, non-Google apps have 25% share ...

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## NBU Markets see 5x faster Lite app adoption ...



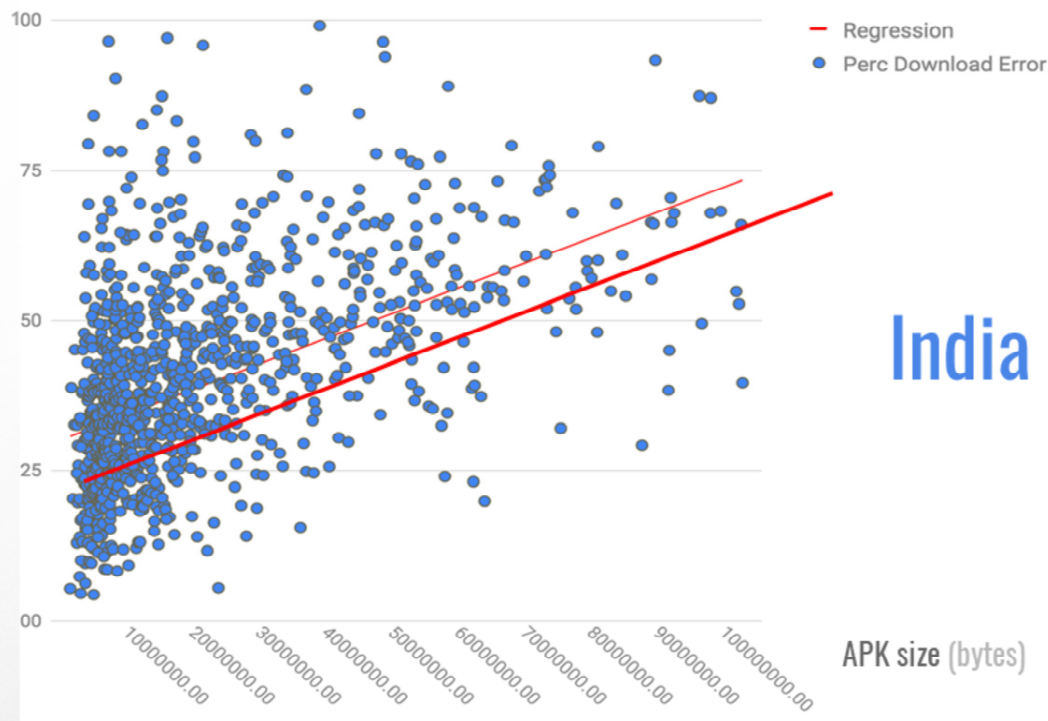
### Apps:

- 360 Security
- Clean Master
- Facebook
- InstaSquare
- LINE
- Opera browser
- UC Browser

Source: [Rise of the Lite Apps ...](#)

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# App download/update failure rates rise with APK / APK patch size ...



APK download/patch size (what is downloaded from the Play Store) is function of APK Size - currently, patch size is at ~50% of APK size ...

The larger the APK size (i.e., if > 10 MB), the higher the failure rate for updates to users from the Play Store ...

Source: % Download Error by APK Size ...

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apps teams efforts

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**EXHIBIT 5963.R-073**

## System Health a 3 pronged approach ... by teams



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- Teams are taking a 3 pronged approach:
- a) Shrinking APK size and RAM footprint;
- b) Disabling features on Svelte devices or shipping with just MVP (Minimum Viable Product) features and allowing users to download non-core features on-demand, as-needed; and
- c) Building a lite app from the ground-up, intended address not only device capability needs, but locale feature needs/network realities

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EXHIBIT 5963.R-074

Photos **shrunk** their APK by **50%** to **14MB** ...



- + Remove resource files
- + Compress PNGs better
- + Compress APKs better
- + Compress resources.arsc

**SHRINK**  
to fit

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AGSA used **server-side** optimization to **10x speed** ...



- + Removed Hotword detection
- + Wrapped all components around server-side flags
- + Built Lite Search Results
- + Degraded other features using `isLowRAMDevice()`

**Turn  
features  
OFF**

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## YouTube built Mango @5MB for Low RAM + Bandwidth ...



- + Offline content / videos
- + Targeting Android J+
- + Reducing RAM cache/buffer
- + Target @40mb of RAM
- + Tactical data usage
- + Upselling data within app

Build a  
**LITE**  
app

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Some teams are working on solid *Lite* initiatives ...



YouTube Go



Blimp



Atlas

... others are  
lightening  
existing apps ...



Search Lite



GMS Core

Google Confidential

... while the rest are hashing out their *Lite* strategy ...



*GMM for EM?*



*Photos for  
Low RAM*



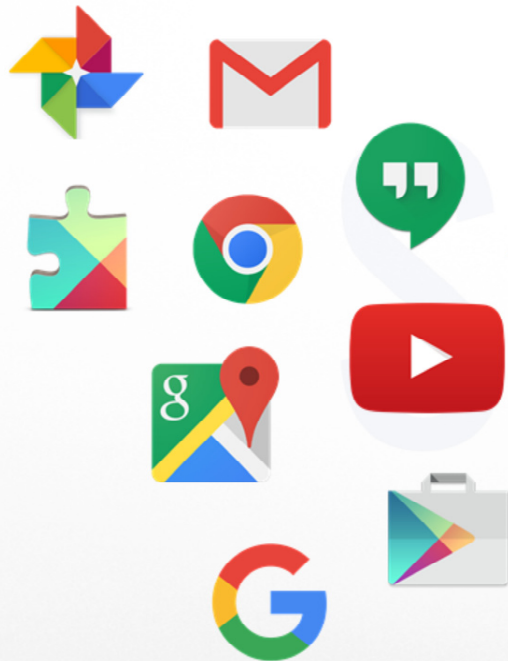
*Gmail for Low  
RAM*



*Fireball +  
Tachyon*

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## What is a Lite GMS App? ...



APK/Play Update Size < ~15 MB *per app*

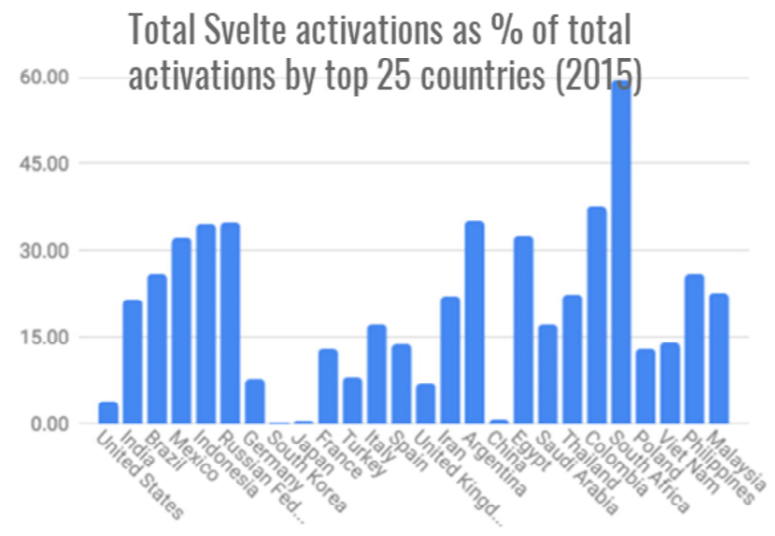
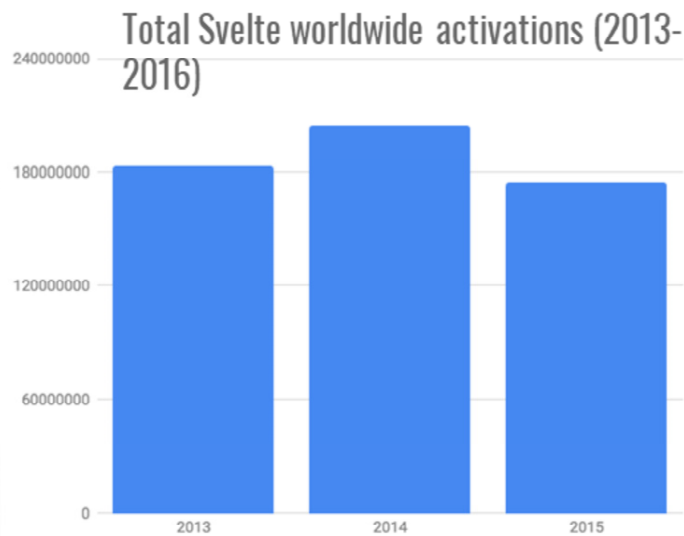
RAM Use ~ 30-40 MB *per app*

Disk Size < ~25 MB *per app*

A Lite App has APK + RAM usage @~30-50% *less* than today's GMS median, at a minimum ...

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## Svelte YoY activations & as % of Total by Country ...



- Total worldwide activations hovering ~200M / year ...
- Svelte activations as % of total average ~20% ...

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# Memory pricing Q416 estimates for 512 MB / 1GB ...

Package	RAM	Flash	Q4'15 Price est	Q4'16 Price est
<b>Discrete</b> <i>DDR3L RAM + eMMC storage</i>	512MB DDR3L	4GB eMMC	~\$4.10	
	256MB DDR3L	4GB eMMC	~\$3.50	
	128MB DDR3L	4GB eMMC	~\$3.30	
<b>Discrete</b> <i>DDR3L RAM + flash storage</i>	256MB DDR3L	512MB SLC flash	~\$2.60	
	256MB DDR3L	256MB SLC flash	~\$2.20	
<b>Discrete</b> <i>LP3 RAM + flash storage</i>	1GB LP3	1GB SLC flash	\$9.00	\$7.50
	1GB LP3	512MB SLC flash	~\$7.80	~\$6.50
<b>eMCP</b> <i>LP2/LP3 RAM + eMMC storage</i>	1GB LP2/LP3	8GB eMMC	~\$8.50	~\$6.00
	512MB LP2/LP3	4GB eMMC	~\$4.50-\$5.50	
<b>MCP</b> <i>&lt;512MB RAM + flash storage</i>	256MB LP2	512MB SLC flash	~\$3.60	
	128MB LP2	256MB SLC flash	~\$3.00	

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Source: ULE Android for NBU ...



## Memory pricing Q416 estimates for 512 MB / 1GB ...

	256MB		512MB		1GB	
	Current	EO 2016	Current	EO 2016	Current	EO 2016
<b>LP4</b>					\$7.60	~\$5-\$6
<b>LP3</b>	Not available	Not available	~\$3.3	low \$2's	~\$6.30	~\$5
<b>LP2</b>	~\$2.95	Mid-\$2's	~\$3.3	~\$3.00	~\$6.20	~\$5.30
<b>DDR4</b>	Not available	Not available	~\$3	low \$2's	~\$7.35	~\$4.5-\$5.0
<b>DDR3L</b>	~\$1.1	low \$1's	~\$1.9	low \$2's	\$4.80	low \$5's
<b>DDR2</b>	Niche, not recommended	Niche, not recommended	Not available	Not available	Not available	Not available

*Actual forward pricing may vary subject to changes in memory conditions*

Source: ULE Android for NBU ...

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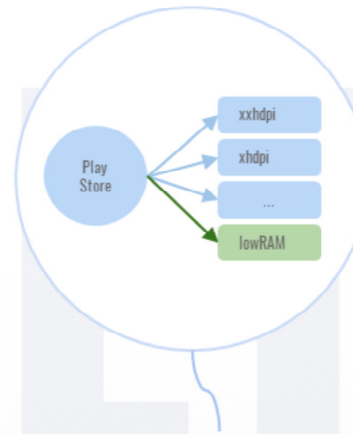
# Efforts support these **APE asks** from Apps by **EOQ3'16**...



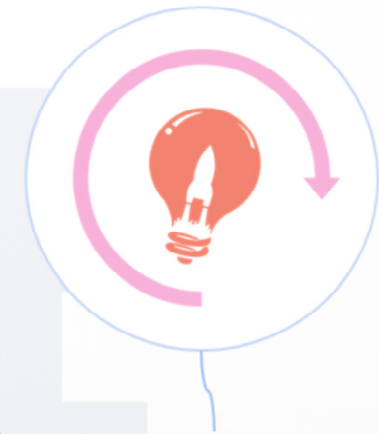
Build **Lite apps**@  
 <= 15 MB APK,  
 <= 40 MB RAM ...



Develop separate /  
**decoupled** Lite Apps  
 for **Svelte** ...



Use Play **Svelte**  
**targeting** to manage  
 Lite app updates ...



Launch Lite apps in  
 target markets  
*quickly & iterate* ...

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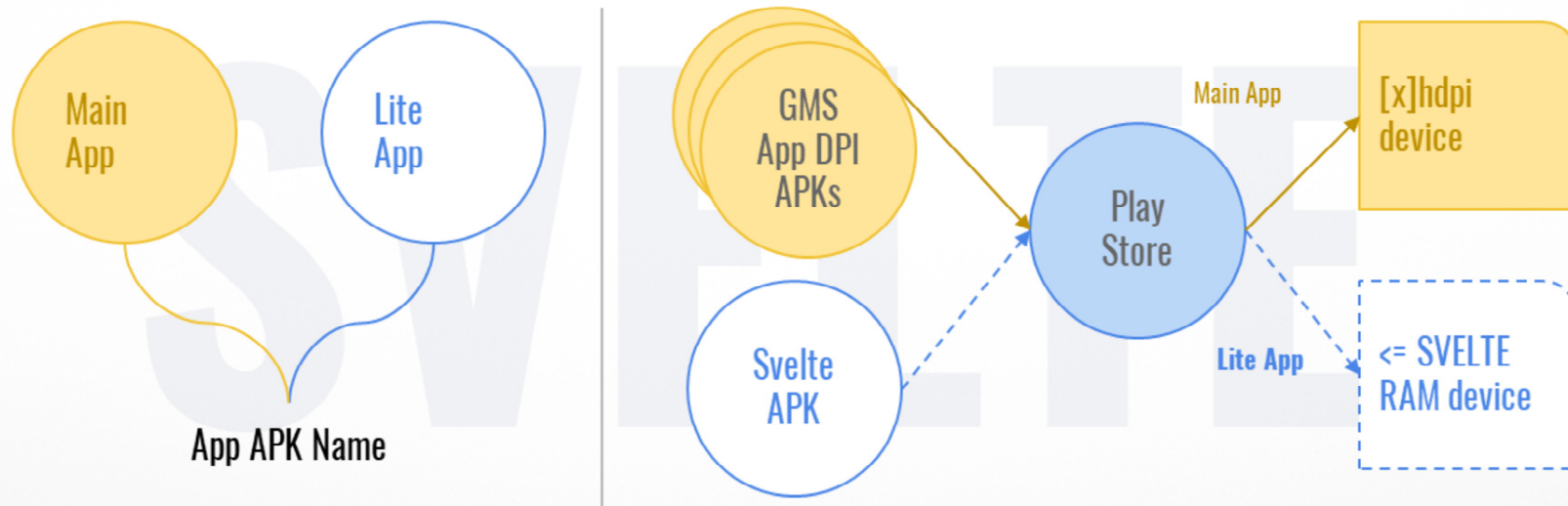
- We'd like Apps teams to converge on the following key asks by EOQ3'16, to ensure we can meet the goal of launching a Svelte device on N by EOQ4'16:
- a) Build new/existing versions of apps with APK/Disk size and RAM footprint in the Lite range (as determined by reference internal GMS Lite apps and external competitor apps)
- b) Develop with separation in mind — some of our core GMS apps tend to serve as platforms for other GMS apps (YouTube / Chrome) — but lowering the overall Core GMS APK/Disk size and RAM footprint means Lite apps shouldn't carry "baggage"
- c) Leverage Play's multi-apk targeting capability which will be expanded to support Svelte devices to release Lite apps in leui of full/regular/main versions of apps
- d) Launch lite apps on devices in BRIIM / NBU markets where risk is low and reward potential high as experimental grounds — operate like startup

GOOG-PLAY-003687216.R

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**EXHIBIT 5963.R-084**

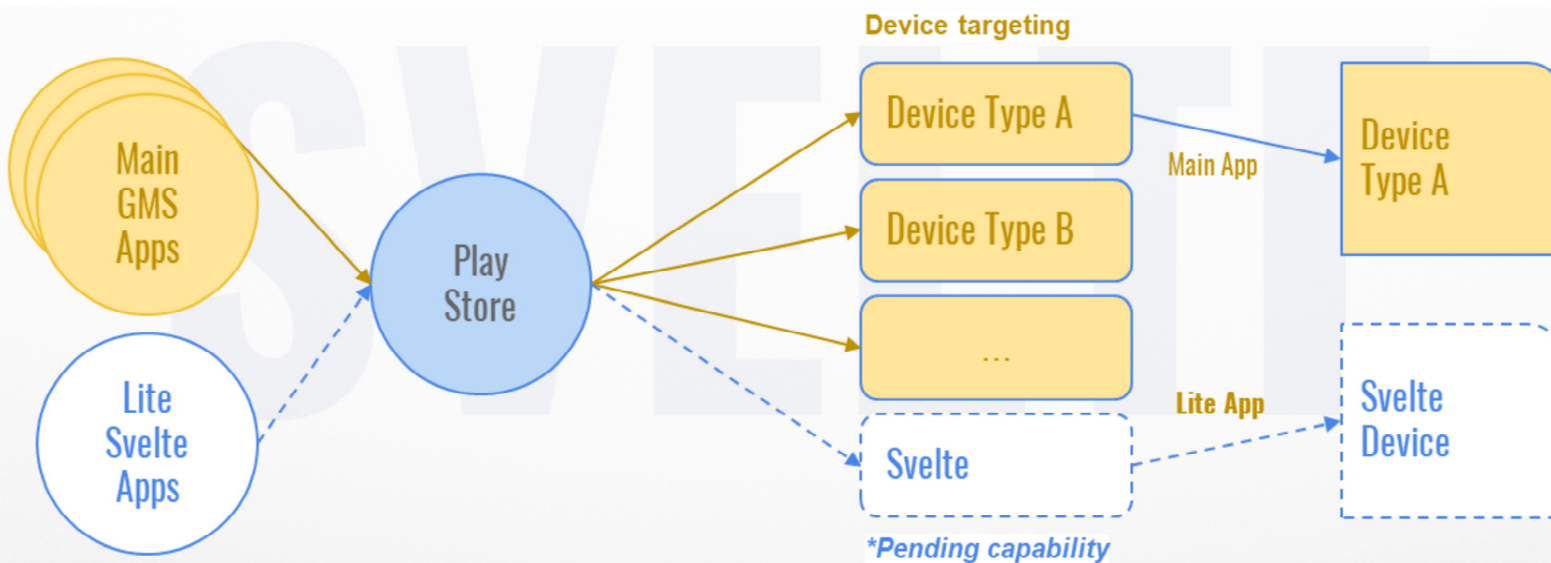
Launching a **Lite version of an APK for Svelte devices** will be much easier going forward for 1P GMS teams ...



... Play will be adding a **Svelte flag/deployment option** allowing deploying Lite app with **existing Main app APK name** ...

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## Proposed Svelte targeting capability in Play\* ...



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# svelte device program

project ílio  
ílio: helium (greek); the lightest element

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## ilio device program specs ...

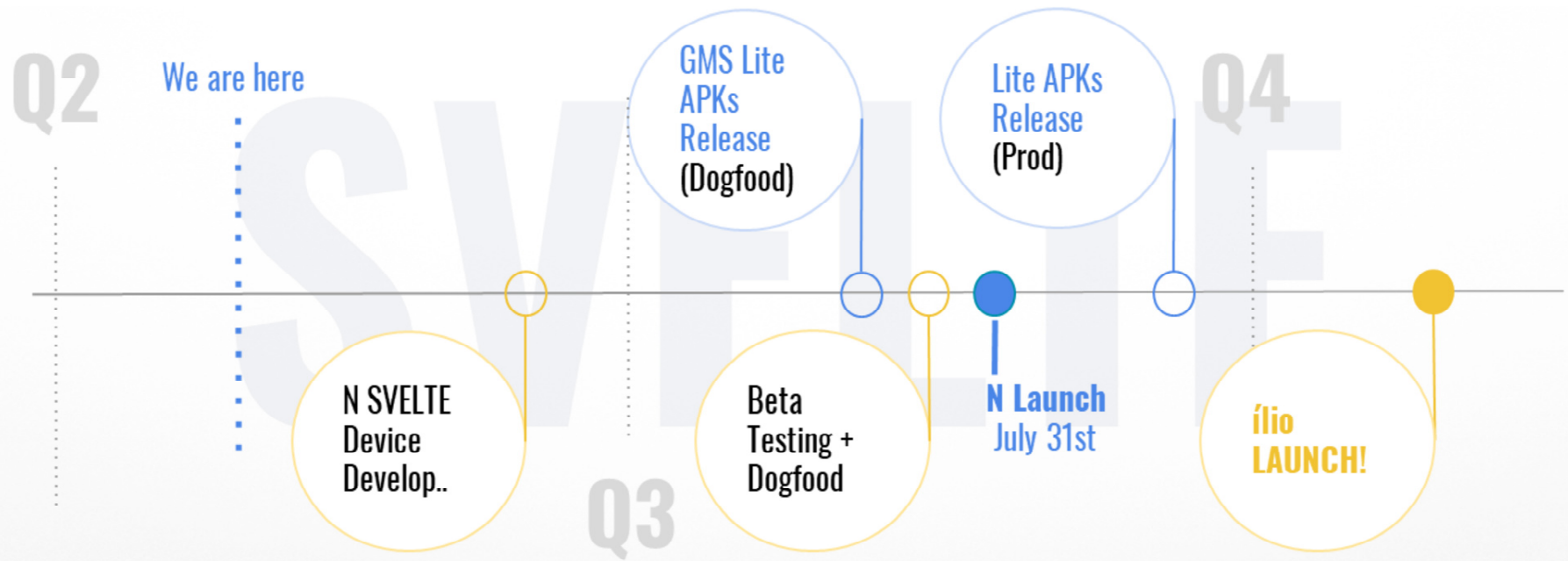


**512 MB RAM**  
**480x800 Screen**  
**4 GB Storage**  
**1.3 Ghz Quad Core**  
**1700 mAh Battery**  
**Android N**  
**ETA : Q4'16**

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## ílio Device Program Key Dates ...



... likely launch for ílio is Q4 2016

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**Ílio** program outputs as devices ... Any combo of **a,b,c** ...



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